A HAND-BOOK OF LOGIC

(Part — 1)

SECOND EDITION

By

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Foreward to First Edition

My main purpose in writing this book is to place into the hands of fresh students of Logic a handy book on the subject, which will combine *sound theory* with *sufficient practice*.

The topics are arranged in the order that is generally followed in the University Examination Questions. " The Predicables, " " Definition " " Division " etc. are, accordingly, omitted from part I (i. e. the present book), in order to be treated in the beigenning of Part II.

On an old subject like Logic, indebtedness to previous writers cannot be adequately acknowledged. However, special mention must be made of the books written by Mellone, and Latta and Macbeath. The conciseness and precision (particularly, in the practical exercises) of the former, and the clearness and lucidity (particularly, in the theoretical discussions) of the latter, have been my constant fascinations.

Poona
5 th February, 1940.

V. P. Patwardhan.

Preface to Second Edition

This second edition is mostly a reprint of the first. The only addition is the topic of " quantification of the predicate " (P. 56-7). In order that the book should be more useful to students, questions of Bombay University Examinations have been given in Appendix, and pages of the book where answers to the questions may be obtained are indicated. An index to topics is also added.

23rd June, 1948.

V. P. Patwardhan.

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CHAPTER I

THE GENERAL NATURE OF LOGIC AND ITS RELATION TO ALLIED SUBJECTS

(A) The General Nature of Logic

(1) Definition and Scope of Logic

Logic may be defined as the study of the structure of reasoning, its various types, and of the conditions which valid reasoning must satisfy; that is, the study of the factors that make up reasoning, the different ways in which reasoning is carried on, and the standards to which correct reasoning must conform. As reasoning plays a very important part in the acquisition of knowledge and knowledge helps life by farsight and foresight, logic is occupied with a very vital question. Knowledge is only another name for the system of our judgments. It is obtained in one or more of these three ways—

(1) By direct perception; for example, I know that the wind is blowing hard while I am writing because I feel the touch of it. (2) By intuition; for example, I know from inside me that I am alive; and I know that things equal to the same thing are equal to each other. (3) By inference from judgments already known or based on facts of observation; for example, seeing

the list of successful candidates and not finding my friend's name in it, I know by inference that he must have failed. I know that the Earth is round from the observation that the mast of an approaching ship is seen first and the keel last. Most of our judgments in the practical concerns of life are of this derived nature; and logic, as it studies the question of the correctness or otherwise of such derived judgments or inferences, renders great service in the cause of knowledge. However, logic is concerned primarily with the correctness of connections between judgments; and as judgments are about actual things only secondarily with their truth. It is the task of logic to point out how judgments ought to be connected with other judgments and with facts of observation. Logic does not dabble with any particular argument, but deals with the *general* character of the various types of argument and the *general or formal* conditions of their validity, whatever be the particular subject matter of the arguments. In this way the scope of logic is very wide—as wide as almost the total field of knowledge.

As regards the detailed study of logic, it is customary to study it under the following heads:—(1) Terms, (2) Judgments (3) Reasonings and (4) Processes auxiliary to clear thinking, such as observation, definition, division, classification etc.

(2) Is Logic Purely Formal?

As logic studies the different *forms* of all reasoning, and not the special subject matter of any particular reasoning, it is a study of the forms of thought; and therefore a *formal* science. But every other science also is more

or less formal in as much as it frames the *general* principles or laws irrespective of the particular things that obey those laws. For example, the study of Physics does not tell us the particular place of stoppage of a particular ball hit by a particular batsman on a particular playground, but tells us the laws of motion of matter in general. Logic is more formal because it has a more abstract subject matter, viz. thought itself. But though logic is bound to be more formal, in the sense of being more abstract, than most other studies, it would be wrong to conclude, as Hamilton does, that it studies only the forms of thought to the total exclusion of the matter of thought. Everything in the world can be looked at in two ways :—(1) from the point of view of its matter or content ; and (2) from the point of view of its form. Two things may have the same matter but different forms. For instance, a table and a chair have different forms but the same matter, namely wood; and two things may have the same form but different matter, as, for instance, two tables of the same form may be made of two different materials like wood and marble. Similarly, we can distinguish between the form and matter of thought. Two thoughts may be the same materially but different formally; for example, the two judgments 'All men are mortal' and 'No man is immortal' tell the same thing in two different forms: on the other hand, two thoughts may be the same formally but different materially; for example, the two judgments 'All men are mortal' and 'All birds are feathered' are of the same form but different in their subject matter. But though it is thus possible to distinguish between the form and matter of a thing or of a thought, it is not possible to separate them, because

the two are closely bound up. The form of a thing will be largely determined by its matter and matter must always have some form. Similarly, as thinking is about something and not in vaccuo, the form of thinking is bound to be affected by the matter. What form may validly be given to a thought will very often depend upon the actual subject matter. For example, though the propositions, "A triangle is a three-sided rectilinear figure" and "A horse is an animal" are the same in form (viz. Universal affirmative), the process of inference called conversion cannot be applied to both to the same extent. The first can be converted simply; the other by limitation. It is the consideration of the matter that makes the difference. In the case of some forms of reasoning, for instance, the dilemma, the validity of the argument has to be decided by material considerations. Logic therefore, cannot totally exclude the matter of thought though its chief concern is with the form.

Logic is divided into two branches, one called deductive or formal logic or logic of consistency, and the other called inductive or material logic or logic of truth. This division is based on the two different types of reasonings viz. (1) deductive reasoning, where a general principle is applied to a particular instance, and (2) inductive reasoning, where a general principle is inferred to be operative, from observation of facts. Even here, the terms 'Formal logic' and 'Material logic' are misleading. In one sense, all logic is material as seen above. In another sense, all logic, even the inductive logic is formal, as all that it can do is to determine the forms of correct reasoning irrespective of the actual subject matter of the inquiry. The two types of reasoning should

therefore be called deductive and inductive and not formal and material.

(3) Is Logic a Science? If so, in what sense?

So far we have called logic a study of the principles of valid reasoning. May it not be called by the more dignified word 'Science'? The word, 'science,' generally raises before our eyes a picture of some apparatus and of some concrete subject matter of study, as in the sciences of Physics, Chemistry etc. Considered from this common view-point, logic is not a science. But by science is really meant 'A *methodical study* of the general principles of some *definite* subject matter'; and in this broad sense, logic is certainly a science, as it studies, in the most systematic way, the general principles of the validity of reasonings. Its subject matter, though abstract, is yet quite definite. Hence, logic may very well be called the *science* of reasoning.

Not only is logic a science, but it is a 'Science of all sciences' (Scientia Scientiarum); Every other science is a body of connected thoughts; but how far the thoughts are properly connected, whatever the subjects of thought, is to be determined by logic. It has, therefore, to supervise and regulate the thinking processes involved in all the other sciences. It is not a science of all sciences in the sense that it is the sum total, or encyclopaedia, of all knowledge, but in the sense that all sciences have to submit to the principles laid down by logic.

In order to fully understand the nature of logic as a science, it is necessary to classify sciences under two broad divisions—(1) Positive or Natural sciences and

(2) Normative sciences. Positive or Natural sciences are those that describe the actual nature and uniformities of behaviour of their respective subject matters. By a normative science, on the other hand, is meant a science that undertakes an enquiry into the ideals that ought to be followed in their respective spheres. The majority of sciences are of the positive type—for example, Physics, Chemistry, Biology, Astronomy, Geography, Sociology, etc. The normative sciences are few in number,—in fact, they are three: and Logic is one of them, Ethics and Aesthetics being the other two. These three sciences study the '*norms*' or standards of correct thought, right conduct and true beauty, *respectively*. Of course, what is ideal thought, ideal conduct, or ideal beauty, will much depend upon the actual thought conduct and beauty. But the main concern of a normative science is to study the ideals and not the actuals. So logic, being concerned to know the standards or norms of valid reasoning, is a *normative* science of thought.

(4) Is Logic an art? if so, in what sense?

To call logic a science raises the question whether it is a science only and not an art at all. Before deciding this issue, it is necessary to distinguish between science and art. By science is meant a theoretical study of the subject; and by art is meant some practical application. Science emphasises the *knowing side*; art, the *doing* side. Science depends solely on mental capacity, while art must depend more or less on physical skill. The one dives deep into the subject, the other plays with the superficial externals. The one studies *Principles*; the

other follows *rules*. Carpentry, cycling, swimming typing etc. are obviously arts. Proficiency in them requires practice rather than theoretical knowledge. However, almost every study has both sides—the theoretical and the practical--which are interdependent. No theory can be built up unless there is the practice in some form. Practice, in fact, comes first and then the theory. The child learns to walk long before it knows the principles involved in walking. But it is equally true that there can be no practice unless there is some theory to be practised. There can be no proper doing of anything unless the plan of it is first determined in the mind. Art or practice may proceed to a certain limit without the theory or science: but beyond that limit, progress must depned upon the study of theory. Similary, when theory is advanced, it will not fail to be applied to some practical use. In logic, too, the theory and practice are different. The theoretical study of Logic does not necessarily make a person a better argumentator; and on the other hand, a person may be a good argumentator without knowing even the rudiments of logical theory. It was to emphasise this difference that Locke said, "God did not create man and leave it to Aristotle to make him rational". Indeed, Aristotle did not make men think—they were thinking long before; but he made them *think about thinking*. If however, by art is to be meant a study which is of some *practical application* in human affairs, logic can not fail to have this side. Knowledge of the theory of logic is bound to make a better thinker. The following are some of the practical uses of Logic. (1) It enables one to detect, correct and thereby to avoid errors in thinking. And as thought and exchange of

thought form a large part of human behaviour, Logic is of immense advantage. (2) Moreover, it gives training to the mind and sharpens the intellect. Once accuracy of thinking is attained, it can be applied to all practical concerns. A person who knows logic is less likely to be imposed upon by false pretences because he can easily detect them. (3) Logic has a great cultural effect as it shows the way of knowledge as distinguished from the way of mere opinion or belief or superstition. (4) And lastly, logic leads us on to the knowledge of ultimate reality on which depends our general well-being. In a broad sense, therefore, logic is an art as well as a science.

(B) Relation of Logic to allied subjects

So far we have ascertained the general nature of logic from the positive side. From the negative side, it will give us a clearer view of its nature, to know what it is not.

(5) Logic and Psychology

Logic is quite distinct from Psychology. Though thinking is the common subject matter of both logic and psychology, it is studied in quite two different ways by the two sciences. Psychology studies the *actual working* of thought, for example, how thought begins and develops in the human mind; what are attention, memory etc. Logic is concerned with *ideal thinking*, thinking as it ought to be. Psychology ascertains how we think, logic how we *ought* to think. Psychology studies the actual *processes* of thinking, that is, thinking in the making, while logic wants to ascertain the validity of the *result* or conclusion of the thinking process.

Moreover, psychology must study *all* mental workings, and not the intellectual workings only. It has to study the origin and growth of different emotions, sentiments, appetites, desires, volitions etc. of the human mind in addition to the cognitive processes. If human mind is supposed to have the three faculties of knowing, feeling and willing, psychology has to study all of them, while logic has to study only the knowing side and that too only from the point of view of its worth or validity. Psychology, therfore, covers a more extensive field of study than is done by logic. Even then, logic must take the help of psychology; because, after all, the correct or ideal ways of thought can be determined only by reference to the actual: and on the other hand, psychology, like every other science, must be regulated by logical procedure. The difference between logic and psychology can be pointedly indicated by saying that logic is a *normative* science of thought, while Psychology is a *natural* science of thought and of all other mental processes.

(6) Logic and Rhetoeic

Another subject, that comes near logic and yet is distinct, is rhetoric. Both logic and rhetoric have to lay down rules for arriving at conclusions. But the aim of logic is to *convince* by means of consistency of thinking: the aim of rhetoric is to *persuade* or bring round the opponent to the required conclusion by any available means. Logic appeals to the head or intellect; rhetoric appeals to the heart or emotion and imagination. The one is the *science* of reasoning: the other is the *art* of reasoning. Logic in its infancy, i. e. in the hands of the Sophists etc. was

nothing but rhetoric; but Aristotle made it into a science. However, rhetoric, if it is backed up by logical principles, will be all the more powerful.

(7) Logic and Language

The close connection between logic and language can be seen from the derivation of the word 'Logic.' The word comes from 'Logos' which meant *word* as well as *thought*. Logic is sometimes called the 'Grammar of thought,' which indicates that logic is to thought what grammar is to language. Indeed, though thought can exist without an expression for it, it can only be of the simplest type. Complex thinking cannot be carried on without the help of language. More particularly, language renders the following service to the cause of thinking. (1) It enables us to *fix* the meaning, by the use of a word or phrase. That is why words have been called the '*Fortresses*' of thought or 'arches' for the mind. (2) Secondly, it enables us to *record* our thoughts and thereby to recollect them for future use. (3) But the most important help of language to thought is in the *communication* of thoughts that is made possible. Thought spreads by exchange. Language is therefore said to '*canalise*' thinking. However, it must be remembered that logic is concerned with language so far as the latter is an instrument of thought. The main concern of logic is with the *significant thought* clothed in the external expression; and logic must catch the thought and manipulate with it in the most direct manner. If language can be used, it can be abused too; and logic must guard against such abuses, in the interest of clear thinking.

(8) Logic and Mathematics

Both logic and mathematics are highly abstract, formal, and exact sciences; and also, both are equally useful in training the intellect. But mathematics is concerned only with *quantitative* relations: and it can carry on its work by means of symbols without much help of language; whereas, logic has to depend on language at each step.

(9) Logic and Philosophy

Lastly, logic is vitally connected with philosophy which is the study of the nature of ultimate reality of the universe. Logic is occupied with thought by whose means knowledge of reality is to be gained. Knowledge, in fact, means knowledge of reality. The question of logic must therefore lead on to the question of reality. Naturally, the controversies in logical doctrines are due to the differences in the underlying philosophical tendencies. However, it is possible to study elementary logic without bringing in metaphysics.

Questions on Chapter 1.

1 Define logic and determine its nature and scope.
2 "Logic deals with the form and not the matter of thought." Discuss this statement and also discuss the view that deduction is purely formal logic, and induction purely material.
3 Discuss the question whether logic is a science or an art or both.

4 Explain and exemplify the distinction between positive and normative sciences and show how logic is a normative science.

5 "Logic is not the same thing with knowledge, though the field of logic is co-extensive with the field of knowledge." Explain.

OR

What is meant by calling logic the science of the sciences ?

6 "A man who could not think without training could never be trained to think" ; if this is so, what is the value of logic ?

7 In what ways do logic and psychology differ from each other ?

8 How is logic related to language ?

9 Distinguish logic from rhetoric.

10 Mention the resemblances and differences between logic and mathematics.

CHAPTER II

TERMS AND THEIR CLASSIFICATIONS: CONNOTATION AND DENOTATION

(A) Terms and their classifications

(1) The Nature of thought

According to some psychologists, there are three distinct types of the thinking activity, viz. conception, judgment and ratiocination. The first, it is said, produces concepts which when expressed in words are called *terms*: the second combines concepts into judgments which, when expressed, are called *propositions*; and the third produces reasonings which are called *inferences*. This does not seem, however, to be a correct piece of psychology. For, whenever the mind is thinking, it is reasoning. Actually, there is hardly ever a thought in the mind unconnected with other thoughts, The simplest thought, therefore, must be a judgment, that is, thinking something about something. It cannot be a mere concept. The judgment is one whole act of thought and not one made by combining separately existing concepts. To have a concept of a thing is really to think about that thing in some way, that is, to make a judgment. For example,

when I am said to have a concept of a table, I am really thinking that a table has got this or that property, or at any rate, that *it is something that exists*. However, for logical purposes, we may treat of reasonings *as if* made up of judgments, and of judgments *as if* made up of concepts, and study them in the order of concepts, judgments and reasonings—or terms, propositions and inferences.

(2) Meaning of a term

A proposition is a judgment expressed in words and for convenience of study, it may be resolved into terms. //A proposition states something about something else, that is, it has a subject and a predicate.//A term, therefore, is 'a terminus' or one end of the proposition. It is that part of a proposition which is either its subject or predicate.//A term is thus a word or a group of words that stands either as the subject or the predicate of a proposition//

(3) *Term distinguished from concept, word and name*

A term is the expression of a concept. So, in the first place, 'concept' refers to the mental state, while a 'term' is its expression in words. Secondly, by concept is generally meant 'a generic concept' or universal idea, whereas a term is the expression of any idea. For example, it can be said that there is no concept of Tom Brown, though it is a term.

// A term, again, is not the same as a word. It is a word that is capable of standing as the subject or predicate of

a proposition. But some words such as prepositions, conjunctions, adverbs, articles etc. are incapable of becoming terms by themselves (except when something is said about them as parts of speech). Such words are called *syncategorematic*. And words which can be used as terms such as nouns, pronouns, adjectives, etc. are called *categorematic* words. Secondly, a term may consist of more than one word. In the proposition, "The book purchased by me yesterday is to be given as a present to my friend" there are only two terms, each consisting of a number of words.

It is, likewise, necessary to distinguish between words and names, though some logicians, e. g. Jevons and Mill, regard them as equivalent. Names are words with meanings, but not necessarily used in propositions. The words in a dictionary are names. One and the same name may have several meanings, e. g. (1) Pound (money or measure); (2) Capital (money invested, or the chief town); (3) Play (sport or drama); but a term is a name *used* in a proposition and as such has only one meaning.

Classifications of terms

(4) General and Singular terms

Terms may be classified in various ways. Among the most important is the distinction between general and singular terms. A *general term* (sometimes called a common term) is a term which is applicable equally and *in the same sense* to each of an indefinite number of things, having certain qualities in common; e. g. a man, a table, a bird. A *singular term* is a term used as applying

to only *one* individual thing, place or person, in the same sense; e. g. John, Bombay, the strongest man on earth. //It must be carefully remembered that the distinction between a general term and a singular term is one in thought and has nothing to do with actual existence. A term is general or common even when the thing indicated thereby is uncommon or unnatural// For example, a centaur, a unicorn, an emperor of Switzerland, a squared circle, a mermaid. are all general terms. even though the objects indicated by them are imaginary or impossible. They are general because they are *applicable* in a general way (i. e. to any object having the required qualities). //On the other hand, a term is a singular term, even though it might be of very common or frequent occurrence, provided it is applicable to only one individual in one and the same sense// For example, there might be many persons of the same name as Joshi, John, Vasant, Vimal etc. The name may even be extended to animals. Yet in each case only one individual is indicated; and therefore, the terms are singular. As the distinction is one in application, it is obvious that in every living language, terms may change their logical character from general to singular or vice versa. Victoria and Gladstone which originally were singular terms only, have become, in the other meanings they have acquired, general terms, as in the following propositions:—(1) Two *victorias* were standing idle on the road. (2) The traveller carried a *gladstone* in his hand. Similarly, a Daniel, a Shylock, a Portia are general terms. On the other hand, originally common terms like brown, green, swift, kale, gore, or those indicating professions or places, have been turned into singular terms.

Singular terms are of two types, according as they indicate the one individual by name or by description. that is, *Proper names* and *Uniquely descriptive terms*. otherwise called '*Designations*'. The latter are general terms so narrowed in their reference by qualifying words that they ultimately refer to one individual only. John, Socrates, Napoleon, the Ganges, etc are proper names; and terms like 'the bravest man alive'' the centre of the earth', 'Number- 4', 'the first boy in the class' are designations or uniquely descriptive terms. Sometimes, the singular term may be formed by a combination of proper name and designation, e. g. (1) Alexander the Great. (2) Richard I. (3) Shivaji, the founder of the Mahratha empire, (4) Tippu Sultan, etc. The demonstrative adjectives 'This' and 'That' at once turn a general term into a singular one. 'A table' is a general term; but 'this table' is a singular term.

(5) Collectively and Distributively used Terms

Another very important distinction is between the collective and distributive use of terms. A *collective* (or better, 'collectively used') *term* is one which is applied to *a number* of individuals *taken together* as one unit. A *distributively used term* is one which applies to the individuals separately. Terms like (1) library (2) team (3) army (4) college (5) museum, etc. are generally collectively used because they stand for the collection of the individuals concerned as one whole. But it is possible to use these terms as general. For instance, in the proposition, "The British army is a small army", the subject-term is used collectively while the predicate-term is used distributively. It is

not, therefore, possible to say off-hand whether a particular term is collective or distributive. It is the use of the term in the proposition that will decide its nature. This distinction requires careful consideration, as a confusion between the two may lead to invalid conclusions. The following example will illustrate the confusion. "The jury pronounced the prisoner guilty: A was one of the jury;" therefore, "A pronounced the prisoner guilty" is a piece of unsound reasoning on account of overlooking the distinction between the collective and distributive use of the 'jury.' The words 'all' and 'some' are particularly liable to create this confusion. 'All' *might refer to all taken separately* or all taken collectively, as in the following pairs :—(1) All the students filled in their admission forms (distributive use of 'all'): and, All the students lodged a complaint (collective use of all); (2) All the passengers carried life-belts (distributive): and, All the passengers could not be accommodated in one boat (collective); (3) The crew were all foreigners (distributive): and, All the crew saved the passengers (collective). Similarly, 'some' might refer to some considered separately or together. For example, (1) Some French writers brought about the French revolution (collective) ; and, Some French writers were poor (distributive).

In this connection it should be noted that a collective use of a term turns it into a singular term as it refers to the objects as one group. A collective term may be of the proper name type also, e. g. (1) The Himalayas (2) The Hebrides (3) The Balkan States (4) Messers Richardson and Crudas, etc.

Names of materials are generally *collectively* used:

for example, gold, water. But in a particular context they might be used as general terms as in (1) A refined gold, (2) An impure water, etc.

(6) Concrete and Abstract Terms

Another distinction between terms is that between concrete and abstract terms. A *concrete term* is one which stands for a thing (by a thing is here meant that which can become a subject in a proposition); e. g. John, the sea, this table, etc. An *abstract term* is one which stands for an attribute of a thing considered by itself; e. g. whiteness, humanity, acidity, etc. Almost every concrete term has a corresponding abstract term. Actually, a quality cannot exist apart from a thing; but it is possible by abstraction to *think* of the quality as apart from the thing and then that becomes an abstract term. 'Concrete,' in logic, does not mean a sensible, tangible thing; for example, 'mind' is not such a thing; yet it is a concrete term because it is a subject to which attributes can be applied. Whether a term is concrete or abstract will have to be decided by its use. Some words have both applications; e. g courage, colour, virtue, introduction. In "Virtue is its own reward," '*virtue*' is an abstract term but in "Consistency is the virtue of an ass" it is a concrete term. Some logicians suggest that for logical purposes abstract terms should be turned into their corresponding concrete terms; for example, the proposition, 'Democracy ends in despotism' should be rendered into "Democratic governments are things ending in despotism." Though such a procedure would render inference easy, it cannot be always applied without loss of meaning. It is better

to keep the distinction and decide the nature of th- term according to its meaning. For example, in th proposition, "Health is wealth," 'health' must b taken as an abstract term and 'wealth" as a concret term. Adjectives must be called *concrete* terms as th noun or pronoun they qualify must always be presen in thought; thus 'white' means 'a white thing' and is concrete; 'whiteness' is, however, abstract.

(7) Positive, Negative and Privative Terms: Contrary and Contradictory Terms

Another commonly recognised distinction is that between a positive term and a negative term. It is really a distinction between an affirmative and a negative proposition, but has been transferred to the realm of terms. *A positive term* is one which implies *the presence* of a quality or set of qualities: for example, white. A *negative term* is one which implies *the absence* of a quality or qualities: for example, colourless. A *privative term* is defined as a term which implies the absence of a quality which was expected naturally to be present or which was capable of being applied; for exampl blind, deaf, dumb, etc. Indeed, this is a very precariou test; for there cannot be any unanimity of opinio with regard to what is a naturally expected quality. An how can the capacity of a thing be pre-judged? Moreover for logical purposes it is altogether irrelevant whethe the quality is absent on account of inherent nature o on account of an accident. So long as the absence i indicated, for whatever reason, it is *a negative term*. Bu even the distinction between positive and negative terms, though easily definable, is not easily applicable. For there can be no purely negative term. Every

negative term must carry some positive meaning with it, It thus becomes only a difference of emphasis. In some pairs of contrasted terms, it is easy to say which is positive and which negative; e. g: lighted-dark, coloured-colourless, Indian-foreign; but in the following pairs, it will be increasingly difficult to ascertain which is the more positive:—temperance—intemperance (Does not 'intemperance' mean something more than mere absence of temperance, ?) Justice—injustice; happy-unhappy; pleasure—pain; virtue—vice; good—bad.

However, what is of logical importance is the distinction between contrary and contradictory terms, and not of positive and negative terms. *Contradictory terms* are those which are mutually exclusive and collectively exhaustive of the whole context or 'universe of discourse.' (Vide note on 'The universe of discourse' at the end of the Chapter) *Contrary terms* are those which are mutually exclusive but not collectively exhaustive of the universe of discourse. For example, taking 'colour' as the universe of discourse, 'white' and 'non-white' would be contradictory terms (white cannot be not-white ; and also no third alternative is possible) ; but 'white' and 'black' are contrary terms, for though they exclude each other, other alternatives like 'green,' 'brown', etc. are possible. According to some logicians, when extreme opposition under the same context is indicated, as by 'black' and 'white,' the terms are said to be contrary, but if the opposition is just sufficient to exclude each other, they are said to be merely '*incompatible*' terms ; for example, 'white' and 'green'. Logically, however, incompatible terms are the same as contrary terms. Terms which, though different, do not exclude each other, may be called '*compatible*' terms :

e. g. 'black' and 'polished'. Whether any two given terms are contrary or contradictory or incompatible or compatible is a question to be decided by our actual knowledge of the matter. For example, 'walking' and 'running' are incompatible or contrary terms; 'asleep' and 'awake' are contradictory terms; and 'sitting' and 'writing' are compatible terms.

A strictly formal and therefore, unquestionable, way of forming the contradictory of a given term consists in prefixing the word 'non' or 'not' to it; but very often this makes the term indefinite or indeterminate which has hardly any value. Aristotle rightly objected to the use of such indefinite terms. For example, what meaning has such a term as 'not-man'? The words, 'other than,' may sometimes be conveniently used to indicate the contradictory.

(8) Absolute and Relative Terms

Terms may also be classified as absolute and relative. *An absolute term* is one which refers to a thing regarded by itself, that is, without reference to any thing else; for example, apple, sound, man. A *relative term* is one which has a necessary reference to some other term deriving its denomination from the same fact which is the ground of the first term; e. g. greater—less, king-subjects, mother—child. The terms mutually implying each other are called *co-relatives*. In a sense, there can be no absolute term, as nothing stands absolutely unrelated to the rest of the world; but so far as the relation is not taken into consideration, it may be treated as an absolute term. If an absolute term is taken relatively or vice versa, there is much confusion of thought, as the

following example will illustrate :—Shivaji was a child (of Shahaji); therefore. Shivaji was a child (even when he crowned himself king).

(9) Univocal, Equivocal and Analogous Terms

Some logicians make the above mentioned classification of terms. By *a univocal term* they mean a term (really a word or phrase) that has only one meaning ; e. g. man, table, etc ; by *an equivocal term*, a term that is capable of being used in more senses than one ; e. g. pound, capital, fair, etc. and by *an analogous term* they mean a term that has more than one, but similar, meanings ; e. g. the foot of a mouutain, the head of a family, etc.

This is, really, a classification of words and not of terms. A term is a word or words used in a proposition ,and as such it must have only one meaning. However, this distinction draws attention to the logical importance of using a term in one and the same sense throughout a discourse.

(B) Connotation and Denotation of Terms.

(10) Meaning of 'Connotation'

To the above distinctions of terms Mill adds one more, viz. the distinction between connotative and non-connotative terms. Whether such a distinction can be maintained depends largely on the meaning of the word 'Connotation'. Generally, *the object or objects or the varieties of objects* to which a term refers are called its denotation or extension ; and *the quality or qualities;* which the objects referred to possess, are called the connotation or intension.

But as there are many qualities a thing may possess which of them are to be called its connotation? Dr. Keynes has pointed out that there are at least three different points of view from which the qualities of things may be regarded:—(1) In the first place, there is the *conventional* intension or 'connotation'. It means the essential qualities, that is, the qualities which define the thing and without any one of which the thing will cease to be called by that name. Connotation, in this sense, means the minimum number of qualities required to be called by that name. *Thus the qualities of 'animality' and 'rationality'* form the connotation of man. The connotation of a triangle would be being a rectilinear figure and having three sides. (2) Secondly, there is a *subjective* or relative intension which comprises the prominent qualities. This may vary with different persons, or with the same person at different times. The technical meanings of terms are types of subjective connotation; for example, the subjective connotation of 'Person' is different for Ethics and Law. So also, 'Water' connotes a certain set of qualities to a farmer, another to a swimmer, and a third to a chemist. Such connotation may include some unessential qualities and may exclude some essential ones. (3) Thirdly, by connotation may be meant the sum-total of all the qualities, known as well as unknown. This is called the *objective* connotation or '*comprehension*'. From this point of view, the connotation of a term like 'man' who is an infinitely progressive being, (or for the matter of that of any other term), would be infinite. In the majority of cases, by connotation is meant the conventional connotation; but as terms cannot have a fixed connotation, it is necessary to recognise the subjective intension also.

Hence, what is meant by connotation is, always, 'some qualities,' that is *some definite meaning* which must remain the same in any connected discourse or reasoning. In a general way, therefore, 'connotation' means *qualitative meaning*.'

(11) Limits of Connotation; or, are there any Non-Connotative Terms?

According to Mill, there are two kinds of non-connotative terms :—(1) Proper names and (2) Abstract terms. In order to understand this distinction made by Mill, it is necessary not only to know the meaning he gives to 'connotation', (viz. conventional connotation) but the peculiar meaning he gives to the words, 'connotative' and 'non-connotative'. ['*A connotative term*', according to Mill, 'is one which denotes a subject *and* implies an attribute]; for example: bird, member of parliament.' [*A non-connotative term* is one which signifies an attribute *only* or a subject only']; for example, whiteness, John Smith etc. In short, proper names and abstract terms are *non-connotative*, according to Mill, because (1) The proper name signifies a subject without implying attributes and (2) The abstract term signifies an attribute without implying a subject. Thus, according to Mill, an abstract term has connotation and yet is non-connotative, as it does not, in addition, possess (in his opinion) denotation. Dr Fowler, who accepts Mill's theory of non-connotative terms, suggests that *three* kinds of terms should be recognised :—(1) Terms which both connote and denote (2) terms which only connote and (3) terms which only denote. Even after this modification, which makes the distinction easier to understand, it is not possible to accept Mill's doctrine.

If by connotation is meant conventional connotation, then proper names are non-connotative, as, being singular terms, they do not imply any common qualities possessed by the individuals of those names. But if by connotation is meant 'some qualitative meaning', it is hard to see how proper names are non-connotative: for whenever a proper name is used in a proposition, it implies some *qualities* and carries some meaning. No term can be meaningless. Mill says, 'A proper name is but an *unmeaning mark* which we connect in our minds with the idea of the object, in order that whenever the mark meets our eyes, or occurs to our thought we may think of that individual object." But if the proper name serves the purpose which Mill assigns to it in the above remark, how is it '*unmeaning*'? In fact, the proper name looks non-connotative, not because it has no connotation, but because it has too much. There are some logicians, for example, Dr. Ray, who try to reconcile the two extreme views about the connotation of Proper names by saying that Proper names have no original connotation, but an *acquired connotation*. But then, every other term also may be said to have an acquired connotation. The term 'table,' one can say, *acquired* connotation when it was brought into use to indicate certain qualities possessed by the objects. If it is meant that a proper name *is* unmeaning outside a proposition, equally unmeaning is any other term. So no such distinction can be made. Similarly, it is wrong to suppose that abstract terms have only connotation and no denotation. An abstract term can be made to stand as the subject of a proposition, as in the proposition, "Whiteness is dazzling" and then it must have denotation. The abstract term denotes and

connotes the same attributes. To think of anything is to think of the object as well as of the qualities possessed by the object. Every term, therefore, as it has a qualitative meaning and a denotative reference, must possess both connotation and denotation which are its two aspects.

Q. State & explain Inverse Relation between C & D

(12) Relation between Connotation and Denotation

As regards the relation between connotation and denotation, it may be said in a general way that they *vary inversely*. This may be expressed in four formulas:—viz. (1) As connotation of a term increases, its denotation decreases (2) As connotation decreases, denotation increases (3) As denotation increases, connotation decreases (4) As denotation decreases, connotation increases.

It is obvious that the greater the number of qualities connoted by a term, the fewer will be the objects to which the term is applicable: and conversely, if the denotation is to be wider, some of the qualities must be omitted from the connotation. For example, the term 'student' has a wide denotation; the term 'college student' which has increased in connotation will be applicable to fewer individuals, that is, will have less denotation; and the denotation will go on decreasing as we attach more qualifying adjectives like 'Indian,' 'belonging to an Arst college,' etc. On the other hand, if the denotation of 'college student' is to be increased, the word 'college' will have to be taken out from the connotation.. Similarly, 'ship', 'steam-ship', 'screw steam-ship', 'British screw steam-ship' have increasing connotation and decreasing denotation. But this rule of inverse ratio has certain restrictions and exceptions.

(1) In the first place, it holds true of terms which can be arranged (as in the above illustrations) in a classificatory *series, that is, in divisions and subdivisions.* Unless the terms given can be brought into one line no comparison can be made. (2) Secondly, the ratio *cannot be a mathematical one. For a ratio can exist* between two quantities. As connotation cannot be calculated quantitatively, that is, as connotation and denotation are incommensurable, no mathematical relation can be established between them. (3) Thirdly, the ratio is not inverse in any exact way, but only roughly. The addition of one quality to the connotation may decrease the denotation far more than the addition of some other quality: for example, the adjectives 'red' and 'white' applied to 'man' do not reduce the denotation equally. (4) Fourthly, the relation holds true only if a *really new* quality is added. The words, 'mortal', 'black', 'equiangular' as applied to 'men', 'crows' and 'equilateral triangles,' respectively, do not affect their denotation. There are also exceptions to the rule :—(1) If by connotation is meant the known qualities, it may increase without any decrease in the denotation. For instance, the connotation of 'the sun' has increased since ancient days but the denotation is the same as before. (2) Similarly, if by connotation is meant 'essential *qualities*,' a change in denotation does not necessitate a change in connotation for example, the death of a fly or the birth of a baby does not affect the connotation of either 'fly' or 'baby.'

(13) *Priority between* Connotation and Denotation

Explain Con. & Den. are inseparable aspects

If a term has both connotation and denotation, it may be asked, 'which comes first?' Mill suggests that,

historically, the denotation comes first and the connotation is determined by comparison of the individuals; while *logically*, unless the connotation (or the definition) is known, the individuals or classes of individuals cannot be determined. But the priority question is a needless one. [For we cannot denote an object without recognising certain characteristics in which it agrees with others, that is, without giving some connotation however vague or imperfect. Similarly, we cannot know the connotation unless the objects to which it is applicable are known. In short, connotation and denotation have a simultaneous exitence. They are only the two inseparable *aspects* of every term just in the same way as the substance and the attridutes are inseparable aspects of a thing. As a substance cannot exist without attributes or attributes without a substance, connotation cannot exist without denotation or denotation without connotation. Connotation is not merely a collection of attributes but *a system* of attributes; denotation is likewise the objective system referred to. Thus, they are merely two aspects in which a system or *field* of reference is looked at. As they necessarily imply each other, the question of priority between them does not arise at all.]

A Note on The Universe of Discourse.

Two contradictory propositions or terms are said to exhaust "the whole universe" between them; for example, the terms, 'white' and 'not-white'. But if 'not-white were to mean 'anything other than white in the whole universe,' it may mean a box, a bird or the birthdate of Napoleon. This would mean that it practically means nothing. All negative propositions would then be mean-

ingless. But we *do convey* some meaning by negative propositions also ; and that is because the negation indicated is in a particular *special context* or *sphere of* the whole universe and not in the whole universe as such. This special sphere of the universe which gives meaning even to negation is called "*the universe of discourse*" For example, when it is said of a thing that it is 'not-white,' it is implied that it has some colour other than white. Colour is thus the universe of discourse.

Sometimes, the phrase, the 'universe of discourse' is applied to the particular department of *existence* within which the statement is made. For example, when it is said that 'Hamlet was too thoughtful,' the reference is not to a real person but to a person in the world of drama, which is itself a part of reality.

Out of these two meanings of the phrase, it is the first that is logically important, as it becomes the basis for inference. Propositions are always made within a limited range or system of relations: and their real meaning can be understood only by reference to that limited range, or "Universe of Discourse."

Questions on Chapter II

1 Explain what is meant by a term in logic and distinguish a term from a concept, a word and a name.
2 Explain and illustrate the difference between (1) A general and a singular term, (2) The collective and the distributive use of a term, (3) A positive and a negative, term, (4) A concrete and an abstract term, (5) An absolute and a relative term.

3 Carefully distinguish between contrary and contradictory terms, and illustrate your answer by appropriate examples.

4 Write notes on:—(1) A privative term. (2) An equivocal term. (3) A uniquely descriptive term. (4) The universe of discourse.

5 (*a*) State, giving reasons, the logical characteristics of the following terms:—(1) The number 4 (2) A ghost. (3) The Syndicate of the Bombay University. (4) Logic. (5) City.
(*b*) Discuss the nature of the subject-terms in the following propositions:—(1) The policemen surrounded the building. (2) All the angles of a triangle are less than two right angles. ( ) All the angles of a triangle are equal to two right angles. (4) Some French writers brought about the French Revolution. (5) Some men are wise.

6 Distinguish carefully the different meanings of 'Connotation.' Which meaning do you accept?

7 Discuss the view that some terms are non-connotative.

8 "As the connotation of a term is increased, its denotation is decreased and vice versa." Explain and illustrate this rule. Are there any restrictions on, and exceptions to, the rule?

9 "Connotation and denotation are inseparable aspects of every term." Discuss this remark with reference to the question of priority between connotation and denotation.

CHAPTER III

PROPOSITIONS

(A) The General Nature of Propositions

(1) Meaning of a Proposition

Knowledge consists of judgments-that is, in a system of connected judgments. Judgment is thus the foundation of all knowlege, and when expressed, is called a Proposition. *A proposition may*, therefore, be defined as a statement in which something is said about something else. On such a definition, it is likely to be thought that such sentences as 'Boys are boys,' 'What I have written, I have written,' 'Business is business' are not propositions because they merely repeat the same idea; but on closer scrutiny it will be seen that in them something is said, not of itself, but of something else, as the same word or phrase has different meanings in the two places. 'Business is business' means "Business is a concern in which private relations are not to count." That about which the statement is made is the *subject* of the proposition: what is said about the subject is the *predicate*: and the saying of it is the *copula*, which is usually expressed by the words, "is', 'is not', 'are', and 'are not'. The copula merely

indicates the act of connection. It is not a term. Thus, in a simple proposition there are only two terms, the subject and the predicate. A proposition is a *statement*, i. e., is capable of being either true or false. It must therefore be in the *indicative mood*. As regards the tense, it is obvious that every statement at the time it is made refers to the present. The present, therefore, is always the time *of* predication. But the statement may include a reference to the past or future; that is, the time *in* predication may be present, past or future. "Shivaji was the founder of the Mahratha Empire" and "There will be a world-war next year" are quite good propositions. Of course, the strictest way would be to put the copula in the present tense and turn them into "Shivaji is a person who was the founder of the Mahratha Empire" and "My prediction is that there will be a world-war next year"; but if we keep in mind the distinction between the time *of* predication and the time *in* predication, no confusion will arise; and the form need not necessarily be changed to the present tense.

(2) Difference between a Proposition and a Sentence

A proposition must be clearly distinguished from a sentence. In the first place, though every proposition is a sentence, every sentence is not a oproposition. A proposition is a statement, i. e., the expression of a thought and capable of being true or false. But if a sentence, instead of expressing a thought, expresses a question, a command, a desire, or an emotion, it is not

a proposition. The following sentences, because they do not express thoughts, are not propositions:—(1) Where are you going? (2) Read this book. (3) Would that I were a king. (4) Well done! They will become propositions if their meanings are expressed in the form of matter-of-fact statements: for example, if the last of them is turned into "My opinion is that you have done a very good thing." However, the mere form of a question or command need not deter us from calling it a proposition if what is implied is clearly a statement for which the question-form is a mere garb. The following sentences are quite good propositions:— 1 "Can the leopard change his spots?" (the real meaning being, "No leopard can change his spots." 2 "Whoever loved that loved not at first sight?" (= All Love is love at first sight.) 3 "Do as you would be done by" (= One must behave towards others as one would have others behave towards one). 4 "Over-eat and fall ill" (= Over-eating is a cause of illness).

Secondly, in a proposition, the subject must stand first and the predicate afterwards. In a sentence, the order may be reversed. Especially in poetry, the order is often changed to heighten the emotional effect. Hence, the following sentences are not in the propositional form:— (1) Great is Diana of the Ephesians (2) Blessed are the merciful (3) All, all are gone, the old familiar faces. (4) "Few and short were the prayers we said." (5) "Sweet are the uses of adversity."

Thirdly, the logical subject and predicate may be different from the grammatical subject and predicate. In (1) "You can never say what will happen to-morrow", 'You' is the grammatical subject; but logically it is a

statement about 'all persons.' Similarly, In (2) "We know what matter is by means of our senses." the logical subject is "knowldege of matter." In (3) "Bombay is 1?0 miles from Poona." not 'Bombay,' but 'distance between Bombay and Poona,' Is the logical subject. In (4) "He jests at scars who has never felt a wound," the logical predicate is not 'jesting,' but "not feeling a wound", and the proposition, if it is to convey its real meaning, should read as, "He who jests at scars has never felt a wound."

Lastly, a sentence is not the same thing as a proposition, because one sentence may contain more than one proposition; e. g., "One and three are odd numbers" is one sentence but two propositions; and "The cow, the antelope and the goat, are horned animals" is one sentence but three propositions.

(3) Categorical and Conditiooal Propositions

Propositions are mainly of two types. Every proposition is made under restricrions or conditions; but so long as the conditions are nor expressed, it is a *categorical* proposition; for example, 'Slavery is justifiable". When the condition is explicitly stated, it is a *conditional* proposition. The condirion may be stated either by the use of 'if' or by 'either—or.' The former is called a Hypothetical proposition. Examples:—(1) If Aristotle is right, slavery is justifiable; (2) If the sky is clouded, the sun will be invisible. The latter is called 'a Disjunctive proposition.' Examples:—(1) A student musr take either logic or mathematics at the Intermediate Arts Examination; (2) Either Aristotle is wrong or slavery is justifiable.

(B) Categorical Propositions

(4) Simple and Compound Propositions

Categorical Propositions are sometimes divided into 'simple' 'complex' and 'compound' according to the nature of the sentence embodying the proposition. But it is not right, from the point of view of Logic, to recognise such a distinction. A proposition cannot be said to be a complex proposition because the sentence is complex: for example, the proposition, "The book which I bought yesterday is to be given as a present to my friend" is not a complex proposition but a simple one. Similarly, a compound sentence need not always be a compound proposition. It is difficult to give a definition of a compound proposition that will be acceptable to all, but the following will be generally acceptable:—"*A compound Proposition* is a statement which, though one in form, requires two or more independent propositions to convey its full meaning." Two types of propositions may, therefore, be called compound propositions:—(a) 'Conjunctive' propositions, in which two judgments are put together, as in (1) Vasant and Vimal are brother and sister, (2) One and three are odd numbers, and (b) Exponible propositions, like (1) Only some students passed the examination, (2) All except the idle are rewarded.

The mere use of the word 'and' does not necessarily imply a compound proposition. None of the following propositions is a compound proposition:—(1) He is intelligent and honest (this is a compound sentence but *two* propositions.) (2) January, February and March, are months of the year (Either *three* propositions or *one* Enumerative proposition.) (3) A and B passed the examination (*two* propositions).

Sometimes, even though the word 'and' is used, the proposition is one because only one idea is expressed, as in the following examples:—(1) A and B are friends. (2) All work and no play makes Jack a dull boy. (3) A carriage and horse stood at the door. (4) "God did not make man and leave it to Aristotle to make him rational." (5) "Early to bed and early to rise makes a man healthy, wealthy and wise."

(5) Universal and Particular Propositions

Every categorical proposition, from the point of view of quantity, must be either *Universal* or *Particular*. A *Universal proposition* is one in which the subject is referred to in its entire denotation. Examples:—(1) All men are mortal (2) None is perfectly happy. A *Particular* proposition is one in which an indefinite part of the denotation of the subject is referred to. Examples:—(1) Some books are interesting (2) Some men are not honest. The logically recognised marks of quantity are '*all*' and '*some*' for universal and particular propositions respectively.

(6) Affirmative and Negative Propositions

Every categorical proposition, from the point of view of quality, must be either *Affirmative* or *Negative*. An *affirmative proposition* is one in which the predicate affirms something of the subject. Examples:—(1) The weather is cold (2) Some poets are philosophers. A *negative proposition* is one in which the predicate denies something of the subject. Examples:—(1) None is perfectly happy. (2) Some men are not honest. Some logicians contend that as a proposition is used to convey

some information, it must always have some positive meaning, and therefore, every proposition should be expressed as affirmative. However, though a negative proposition can be expressed in an affirmative form, it is not desirable, in the interest of clear thinking, so to change it, when the statement is obviously negative in its tenor. Even negation, it should be recognised, is a way of conveying information. The following statements are obviously negative propositions :—(1) I do not study mathematics. (2) There will be no lectures after the recess to-day. (3) Life is not an empty dream.

(7) The Four-fold scheme of Categorical Propositions

Combining the two forms of quantity and the two forms of quality, we get the following *four-fold* scheme of categorical propositions :—

(1) Universal affirmative, called A
(2) Universal Negative, " E
(3) Particular affirmative, " I
(4) Particular negative, " O

The names A, I; and E, O are given after the vowels contained in "Affirmo' and 'Nego'.

The following symbolic forms are used for these four types :— All S is P — A (or SaP)
No S is P — E (or SeP)
Some S is P — I (or SiP)
Some S is not P — O (or SoP)

The meaning of 'all' and 'some' must be carefully understood. "All", in the A propositioo, means all of the stated subject; so that, even when the predicate is applied

to all *with exception* or *modification*, the proposition is still universal; for example, the proposition, "All the planets except the Earth and Mars are uninhabited" is logically a universal proposition, though actually, some or only one planet may be inhabited. The quantity is to be judged from the intention of the speaker or writer. In the E Proposition — No S is P — 'all', though not actually used, is meant, because the proposition denies P of all S. If it is put in the form, "All S is not P," it will mean "Some-not" on account of the usage of language. However, even "All – not" means "None' when "all" is used collectively as in "All the endeavours of the doctors were of no use" (E). "All who act honourably shall not be forgotten" (E). "Some" in the I and O propositions means '*Some at least*' and not "Some only" as it very often does in ordinary language. "Some students passed the examination" means, that at least some passed, (perhaps all). The "some" is an *indefinite* some. If a definite part is indicated, it ceases to be a particular proposition; e. g., "Some *ten* workmen were engaged" is not a particular proposition but a universal one.

In actual conversation or writing, we are not careful enough to use the words "all" or 'some; but for clear thinking it is necessary to express a proposition in clear-cut language. "The exercise," says Mellone (*Modern Logic* P. 65), of paraphrasing ordinary or poetical or rhetorical assertions so as to express them in *one* or *other* of the *four standard forms* is a valuable exercise in accuracy of thought and clearness of expression, and strengthens the habit of exact interpretation." Every Categorical proposition must be expressed in one of these four forms.

(8) Numerical Propositions

When the subject term, instead of mentioning "all" or "some," makes an exact numerical reference, the proposition may be called *a numerical* proposition. All such propositions must be treated as universal because the reference to number makes the subject a singular term. Examples :—(1) "Two of them were foreigners." If the emphasis is laid on the exact number, the proposition should be stated as, "The number of foreigners among them was two-(A); or even as it is, it is an A proposition. (2) "Four S is five P"— Propositions of this type are common in Mathematics. Logically, they are universal propositions. (3) "In India, 80 per cent people are illiterate" (A) (4) "Half of his answers are wrong." If the exact half is meant, it is a universal affirmative propositon. If the exact half is not meant, it may be rendered by "Some of his answers are wrong"—(I)

(9) Singular Propositions

A Proposition whose subject term is a singular term is called a *Singular* Proposition. Examples:—(1) "Socrates was a Greek Philosopher." (2) "Honesty is a virtue." Singular propositions must be classed as *universal* as the whole of the subject is referred to. Thus "Love is not love which alters when it alteration finds" is an E proposition. Similarly, "A porter carried my luggage" is a Singular, and hence, a Universal proposition.

(10) Collective Propositions

A proposition whose subject is a collectively used term is called a *collective* proposition. Collective propositions are therefore, universal propositions. If 'some' is used

in the collective sense, the proposition must be treated as a universal proposition and not a particular one. Examples:—(1) " All his endeavours were of no avail ", does not mean ' some-not ', but ' none ', as ' all ' is taken collectively. Hence the proposition is universal negative. (2) " Some writers brought about the French Revolution " = " A group of some writers etc." and therefore, an A proposition. (3) " All the plays of Shakespeare cannot be read in a day " is, similarly, an E proposition.

(11) Indesignate Propositions

Indesignate Propositions are those which have no quantity-mark attached to the subject. They are called ' indefinite ' or 'pre-indesignate' by some logicians. Most of our actual statements are of this type. But, logically, every proposition must be either universal or particular, The quantity must be determined with the help of the context or the most natural *drift* of the statement. It is not proper to read all indesignate propositiong as particular, though such a course is recommended by some logicians on the plea that we must err on the safe side, in stating the quantity. Proverbs and maxims are generally expressed without the quantity-mark: but obviously they are meant to be universal propositions. Examples:—(1) "Murder will out" (2) "A little knowledge is a dangerous thing." But sometimes, even proverbs may have the particular implication, as in, " Stone-walls do not a prison make, " or " Fine feathers do not make fine birds." With regard to indesignate propositions which are not proverbs, the quantity is decided by the obvious truth about it; for example, in "Toys come from Japan" or " Crime is punished," the universal appli-

-cation is out of question. In certain other propositions the quantity is doubtful on account of difference of opinion: for example, " Democracy ends in despotism " is treated as a universal proposition by Mellone, but a particular proposition, by Jevons.

(12) *Exponible Propositions*

An *exponible proposition* is one which, though one in form, requires more than one proposition to convey its full meaning. When the subject is limited by words like 'alone.' ' only,' the proposition is called an '*exclusive proposition* '; for example, " The virtuous alone are happy "; and when limited by words like 'none but', 'except,' etc. it is called an *exceptive proposition*: for example, "No admission *except* on business." To convey the full meaning of these propositions, it is thought necessary to make *two* propositions like, " No non-virtuous people are happy ' and ' Some virtuous people are happy;' and " No persons who have no business are admitted " and " Some persons having business are admitted." However, if the proposition is a universal one, only one proposition, the first one, is enough. as the second proposition follows from the first by way of inference. It should be noted that the exclusive propsition. if it is affirmative. is rendered by a negative universal with the contradictory of the original subject as the subject. The universal affirmative, with the same subject, would be quite wrong. For instance, ' Graduates alone can vote, " or " Only matriculated students attend college " does *not* mean ' *All* graduates can vote' or *All* matriculated students attend college,' because there might be other conditions required to be fulfilled. It can be expressed in the

original quality by making the predicate the new subject: for example, "The virtuous alone are happy" = "All happy people are virtuous." But even this incurs some loss of meaning, and is moreover inferrible from the universal negative proposition with the opposite subject.

But when the exclusive or exceptive proposition is a particular one, it does necessitate *two propositions*, if the marks of exclusiveness are not to be used. For example, "Only some nations are prosperous" means not only "Some nations are prosperous" (I), but "Some nations are not prosperous" (O); otherwise, the force of "only" would be lost.

(13) Modal Propositions

A Modal Proposition is one in which the degree of belief, with which it is made, is expressed. Three kinds of modality are recognised:—(1) The *Apodeictic* or necessary, expressed by the words 'must be;' for example, "Equilateral triangels must be equiangular." (2) The *Assertoric*, expressed by mere 'is': for example, "Men are selfish" (3) The *Problematic*, expressed by 'may be;' for example, "Mistakes may be committed." Sometimes, the modality is expressed in the predicate by words like 'always,' 'sometimes,' 'generally,' 'necessarily,' 'certainly,' 'probably,' etc. For logical purposes, it is necessary to express such propositions in the traditional forms The apodeictic propositions are unquestionably universal propositions; for example, "Equilateral triangles must be equiangular" is logically equivalent to "All equilateral triangles are equiangular." The assertoric should be treated as indesignate and therefore should be ex-

pressed as universal or particular according to the context or drift; for example, "Men are selfish" may mean "All men are selfish" or "Some men are selfish." The problematic are best expressed as particular propositions. "Mistakes may be committed" is the same as "Some mistakes are committed."

When a universal proposition is modified in the predicate by an adverb like 'always' indicating universality, 'always' may be dropped, in the logical form, without much loss of meaning; for example, "Planets always move" may be expressed by "All planets move. Of course, even here, the meaning is not quite the same: but it is at least not misleading. Similarly, when a particular proposition is modified in the predicate by an adverb like 'sometimes' indicating particularity, there is no harm in simply omitting the adverb; for example, "Some men sometimes tell lies" and "some men tell lies" are practically equivalent. But if the modality expressed in the predicate conflicts with the quantity of the subject, it is necessary to change the quantity to suit the modality; for example, "All our efforts *sometimes fail*" must be changed into "Some occasions are occasions when all our efforts fail" (I); and "*Some* of our efforts *always* fail" must be rendered by "All occasions are occasions when some *of our efforts fail*" (A). Singular propositions also must be similarly treated even though the logical expressions may look awkward. "Socrates was *sometimes foolish*" must be expressed in the form of a particular proposition, with "some times" as the subject; and "Man is not all immortal" must be expressed as "Some parts of man are not immortal" (O).

"Necessarily—not" like "all—not" might mean a

universal negative or a particular negative according as 'necessarily' applies to the whole statement or goes with 'not.' For example. Marshy places are, *necessarily* not healthy" is a universal proposition meaning "No marshy places are healthy"; but "Old paths are *not necessarily* the best" is a particular negative proposition.

(14) A fortiori Propositions

The name, "*a fortiori propositions,*" may be given to propositions which have the superlative degree in them. Logically, they are *unicesal* propositions and the superlative degree should be omitted in the logical form. For example, "The longest road has an end" should be expressed as "All roads have an end" and "Even the wisest man is fallible" as "All men are fallible."

(15) Relational propositions

The name, "*Relational* propositions", has been given to propositions which express some more special relation than mere predication. Objects are related to one another in diverse ways–for instance, by relations of *space, time, quantity, family relation,* etc. When such a relarion is stated in the proposition, it is called a relational proposition. Examples :—(1) Brutus killed Caesar (2) A loves B (3) A is equal to, or greater than, B. (4) A is B's brother. (5) A died before B. (6) A is to the north of B; etc.

(16) Existential Propositions

Sometimes, existence, or even non-existence, is predicated of the subject. in a proposition. Examples :—(1) "God is." (2) "There are no ghosts." Such propositions

are called *existential* propositions. These propositions must be expressed thus:—(1) God is a being that exists (A); (2) "No ghosts are beings that have existence" (E).

(17) Analytic and synthetic Propositions

In addition to the above distinctions, one more is recognised by some logicians, viz. the distinction as Analytic or Synthetic (according to Kant), Explicative or Ampliative, or Verbal or *Real* (according to *Mill*). A proposition, in which the predicate only analyses or explains the meaning of the subject, is said to be an *Analytic, Explicative* or *Verbal* proposition; for example, "A triangle is a three sided rectilinear figure": and when the predicate makes some addition to our knowledge, it is said to be a *Synthetic, Ampliative* or *Real* proposition; for example, "A triangle was drawn on the blackboard yesterday."

This distinction is objectionable on the following grounds:—In the first place, if in the analytic proposition, nothing else is contained except what is already implied in the subject, then the proposition would be a mere tautology, that is, would not be a *proposition* at all. Secondly, one and the same proposition may be analytic to one person or at one stage of knowledge, and synthetic to another person or at another stage of knowledge: and then the distinction would have no logical significance. The truth is that a real proposition cannot state *mere identity* or *mere difference* between the subject and the predicate, but states an identity in difference or difference in identity, that is, it states a connection between two things which are not altogether identical. Every proposition is, consequently, both analytic

and synthetic at the same time: and therefore, it would be misleading to make two distinct classes of propositions as analytic and synthetic.

(C) Conditional Propositions

There are two types of conditional propositions:–(1) Hypothetical and (2) Disjunctive. When a condition is expressed by the word 'if,' the proposition is called a Hypothetical proposition: and when the condition is expressed more indirectly, by stating alternatives, it is called "a *Disjunctive* proposition."

(18) Hypothetical Propositions

The symbolic expression for a hypothetical proposition is (1) "If A is B, it is C (or C is B)" or (2) "If A is B, C is D," according as a term is repeated or not; or more briefly, "If S, then P." Concrete examples:— (1) "If metals are heated, they expand"; (2) "If vice is voluntary, virtue is voluntary." (3) "If Aristotle is right, slavery is justifiable." There are two arms in the simplest hypothetical proposition. One of them, the condition, is called the *Antecedent* and the other is called the *Consequent*.

As the relation stated in a hypothetical proposition is the relation of cause and effect, and this causal relation is a universal relation, every hypothetical proposition is a universal assertion. Even though there might be a mark of particular quantity in the consequent, the proposition as a whole is not particular, but universal; for example, "If all men were capable of perfection, some would have attained it" should not be considered as a particular proposition, though the consequent is a parti-

cular proposition. But with regard to the quality, a hypothetical proposition is affirmative or negative, according as the *consequent* is affirmative or negative. The antecedent is not to be taken into consideration in deciding the quality. "If A is B, C is not D" is a negative hypothetical proposition; and "If A is not B, C is D" is an affirmative one.

To put a hypothetical statement in the proper logical form it is necessary to see which is the real antecedent and which the consequent, and state the antecedent first. For example, "*A is C, if it is B*" *will, in logical form*, be "If *A is* B, A is C." *Similarly, the word 'unless'* must be *resolved* into '*if—not,*' and *then the logical* form *given; for* example, "*We* are *beaten unless* help arrives" must become "If help does not arrive, we are beaten."

(9) Disjunctive Propositions

The arms of a *disjunctive proposition* are *called* 'alternatives.' To state an alternative is *indirectly* to state a condition, for if one alternative does not apply, the other must. In symbolic form, the disjunctive proposition may be expressed as (1) A is either B or C, meaning at least, "If A is not B, it is C" and "If A is not C, it is B:" or "Either A is B or C is D" meaning at least, "If A is not B, C is D" and "If C is not D, A is B." Concrete examples:—(1) "He is either a fool or a knave" (2) "Either the witness is perjured or the prisoner is guilty." As the denial *of one* alternative *implies* the affirmation of the other and as the two arms are interchangeable, the disjunctive proposition does not admit of the qualitative distinction of affirmative and negative.

Propositions which combine the hypothetical and the disjunctive elements are really hypothetical propositions. For example, (1) "If A is B, it is either C or D:" (2) "Either if A is B or C is D, E is F" (3) "If he is rich he can either learn engineering or medicine" (4) "If he is either rich or clever, he will succeed" are all hypothetical propositions.

Two minor points should be noted in connection with the disjunctive proposition:—(1) The word 'or' does not always express a disjunction. For example, in "Cows are ruminating animals or animals that chew the cud," 'or' does not indicate alternatives but equivalents. The phrase 'either—or' should be used to express disjunction. (2) Though 'either—or' expresses disjunction, 'neither—nor' does not mean disjunction but conjunction. "He is neither rich nor honest" is not a disjunctive proposition, but a conjunctive one amounting to (1) He is not rich *and* (2) He is not honest, and is different from "Either he is not rich or he is not honest which is a disjunctive proposition.

Questions on Chapter III

1 Explain and illustrate the difference between a logical proposition and a grammatical sentence.

2 Rewrite, giving reasons, the following statements in logical form. [The technical name of the form in each case and hints for solution are given]—

(1) All men are not honest who say that they are. [The subject which is scattered must be collected together. All — not = Some not ∴ O]

(2) Who is not wise after the event ? [Not a real question ; = A]

(3) Hardships are a blessing in disguise
[Indesignate : I, in this case.]

(4) Few men are free from vanity.
[Few = Most not = some not ∴ O
or, "the number of men free from vanity is small" — A.]

(5) Wealth is not the highest good.
[Singular Proposition, ∴ Universal. — E.]

(6) A few Macedonians defeated the vast army of Darius. ['A few' used collectively, ∴ A]

(7) Every day is not a Sunday.
[Every – not = some not, ∴ O]

(8) Only the honest are respected.
[Exclusive proposition = No persons other than honest are respected, — E]

(9) It does not always rain.
[Modal proposition, = Some occasions are r occasions of raining — O]

(10) We cannot all do all things.
[Some persons are not persons who can all things — O]

(11) A few workmen were the only survivo
[= Some workmen survived — I ; and sor men did not survive — O]

(12) All the plays of Shakespeare cannot be read a day. ['All' collectively used ∴ E]

(13) He who would succeed must work.
[He who = All, ∴ A]

(14) All but a few were wrong.
['All' emphasised, ∴ A]

(15) Few men have not suffered disappointmen

['few — not' means 'Some — are' ∴ I; or the number of men etc.' — A]

(16) There is none righteous, : no, not one. [No repetition necessry ∴ "None is righteous" — E]

(17) There's something rotten in the State of Denmark, [Existential proposition, = "Something rotten exists." etc. — A].

(18) Vice never brings happiness. [Modal — E].

(19) One bad general is better than two good ones. [The meaning should be made clearer. "In all cases one bad general acting by himself" etc. — A.]

(20) True Faith and Reason are the soul's two eyes. [Not two propositions but one collective proposition,—A.]

(21) Critics are unsuccessful authors [Indesignate, – must be interpreted as I]

(22) A bird in the hand is worth two in the bush. [Proverb: A]

(23) None came to grief except those who paid no heed to the warning. [The subject to be collected together — E]

(24) That is a mistake [Singular, = "That view is a mistake." — A]

(25) There are frequent contradictions in the daily newpapers [Existential; also modal: the number of occasions etc. —A]

(26) Health cannot be long maintained without

exercise. [Modal. = " No time of maintenance of health without exercise is long " — E.]

(27) It cannot be that none will fail.
[" That none will fail is false " — A]

(28) It is raining. [Rain is something that is falling down — A]

(29) *Many rules of grammar overload the memory.* [' Many ' used collectively, ∴ = ' A collection of many rules etc. — A]

(30) It is two miles to the Railway Station.
[= The distance between this place and the Railway Station is two miles — A]

(31) What cannot be cured must be endured.
[Not a negative proposition, but affirmative-A]

(32) Some one had blundered' [Not a particular proposition, but Singular ; therefore, universal]

(33) Well-begun is half-done. [Proverb — All cases etc. — A].

(34) No batsman can get runs unless he is venturesome and not always then [*Compound Proposition*, = (1) No non-venturesome batsmen get runs — E : and (2) Some venturesome batsmen are not men that get runs — O]

(35) Almost all the others were killed or fatally wounded. [Almost all = Some ; and disjunctive].

(36) The steamer will not sail unless the weather is fair. [= " If the weather is not fair etc. " — Hypothetical Negative].

(37) Neither wealth nor honour did he covet.
[Conjunctive proposition, and not a disjunctive one.]

(38) A is not B, if it is C. [= If A is C, A is not B — Hypothetical Negative]

(39) Methinks nobody should be sad but I. [My idea is etc. — A].

(40) Propositions are either categorical or conditional [Disjunctive proposition.]

CHAPTER IV

IMPORT OF PROPOSITIONS

(A) Import of Categorical Propositions

(1) *Meaning of Import*

By the Import of Categorical propositions is meant the question as to what is the meaning or nature of predication. There are two ways in which the problem is stated:—(1) To what does the proposition as a whole primarily refer? to real things, names or ideas? *This is called the existential import of propositions.* It is more a metaphysical than a logical question. However, it must be mentioned, in passing, that out of the three views on the existential import of propositions, namely, Realism, Nominalism and Conceptualism, the Realistic view must be adopted, because a proposition must ultimately refer to some part of Reality, and not *merely set up a connection between names or ideas.* (2) The second way which may be called the connotative-denotative import, or mere import answers the question as to what kind of relation, respecting connotation and denotation, is expressed in a proposition.

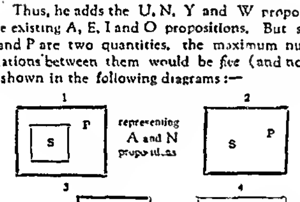
'Napoleon crossed the Alps,' it is an 'accident' that is stated and not a permanent quality.

(3) The Class-view and Quantification of the Predicate

The second view, according to which both subject and predicate are taken in extension, is called the *class view* or class-inclusion theory. On this view, the proposition expresses a relation of inclusion or exclusion between the two classes denoted by the subject and the predicate. This view has some obvious advantages:—(1) In the case of some propositions, this is the most appropriate view to take, as in 'Cows are ruminants' or 'Whales are mammals.' If Classification is taken as the ideal of science, and knowledge is regarded as consisting in placing particular things in their proper classes, then the class view is the right one. (2) Secondly, the processes of inference are made easy, on this view as it lays stress on the distribution of terms i.e. takes the terms in their quantitative aspect. But the defects of the class-view outweigh the merits. (1) It is in most cases the most unnatural interpretation. Can 'The boy fell from the ladder' be interpreted to mean "The boy forms a part of a larger *class of people that fall from ladders?*" Classification is not, in fact, the primary function of knowledge. (2) Moreover, the consequences of the class-view are suicidal to Logic: for it leads, as with Hamilton, to the *quantification of the predicate* which gives us the cumbrous and unnecessary scheme of eight forms of the categorical proposition. Hamilton makes the following eight forms of the categorical proposition by quantifying the predicate :—

1	All S	is	some	P	— A
2	All S	is	all	P	— U
3	No S	is	any	P	— E
4	No S	is	some	P	— N
5	Some S	is	some	P	— I
6	Some S	is	all	P	— Y
7	Some S	is	not any	P	— O
8	Some S	is	not some	P	— W

Thus, he adds the U, N, Y and W propositions to the existing A, E, I and O propositions. But supposing S and P are two quantities, the maximum number of relations between them would be *five* (and not eight) as shown in the following diagrams:—



Thus, three out of the eight forms are superfluous. In fact, proposition N is the same as A; for if all S is only some part of P (A); some P is excluded from all of

S (N). Similarly, Y is not different from O; and W is the same as I. So, only U (where S and P are co-extensive) is a really new form added by Hamilton; but the purpose of an U proposition can be served by two A propositions as (1) All S is P and (2) All P is S. Thus the quantification of the predicate which is the outcome of the class view serves no useful purpose. It further leads to the equational theory of the proposition; for if the exact quantitative relation between the subject and the predicate is to be expressed, the quantities must be more specifically denoted than by words like 'all' and 'some'. The proposition would then take a form like "Four S is five P" where 'is' is interpreted as "is equal to;" that is, the proposition is turned into a mathematical equation like "4 S = 5 P." But the copula "is" does not mean quantitative equality. When the logical proposition is thus turned into a mathematical equation, the possibility of general reasoning is destroyed and Logic becomes a mere branch of Mathematics. But really, Mathematics is a special application of the general laws of reasoning with which Logic is occupied. The class view thus defeats itself by landing into an absurd position.

(4) The Attributive View

The third theory, according to which both subject and predicate are read in intension, is expounded by Mill. It is called the Attributive view. According to this view, a proposition states the co-existence or constant accompaniment of a quality or set of qualities with another quality or group of qualities. For example, 'All men are mortal' means 'the attribute mortality co-exists with the attribute humanity.' *So far as the actual acquisition*

of knowledge and its communication are concerned, this empirical interpretation may be right; but logically a thing is not merely a collection of qualities. Thus the attributive view neglects the essential unity or identity of the thing. Even accompaniment of some qualities with others must have a reference to some common system. Predication is not mere identity, nor mere difference, but indicates a difference in identity. Moreover, mere accompaniment is not sufficient for predication. The proposition must express some real unity. The copula 'is' cannot be interpreted as "is accompanied by or associated with."

So none of the four views can adequately interpret the significance of a categorical proposition, though each of the views may be useful for certain practical purposes, and though the first one—the predicative view—is the most natural. The failure is due to the attempt to separate connotation from denotation and read a term either in one or in the other. But every term has both connotation and denotation inseparably bound together. Therefore, a proposition really expresses a relation of both identity and difference between two terms which are both charged with connotation and denotation. This may be called the '*systematic*' view of the import of propositions.

(B) Import of Conditional propositions

(5) Import of Hypothetical Propositions

Conditional propositions are of two types, the hypothetical and the disjunctive; and by the import of Hypothetical propositions is meant the question whether the

hypothetical proposition cannot be reduced to the categorical form without loss of meaning or whether by such reduction the meaning is distorted.

The Hypothetical proposition, it may be pointed out, indicates a more advanced state of knowledge than the categorical one. This may appear paradoxical, as the categorical proposition states something unconditionally, whereas, it is the Hypothetical proposition which restricts the application by mentioning the condition or conditions. But even in the categorical proposition, the conditions are there, but they are implied and not expressed. The conditional proposition, therefore, gives more definite and exact information by expressing those conditions. For example, if I say that 'War will break out' I am giving more vague information than if I say 'War will break out *if* Hitler invades Poland.' For this reason, the Hypothetical proposition is more employed in science than the categorical one. Examples:—"If metals are heated, they expand." "If the sky is cloudy the sun will be invisible" etc. Now it is possible to turn such propositions into the corresponding categorical form: but thereby there is much distortion of meaning and cumbrousness. Generally, the symbolic form 'If A is B, C is D' may be turned into "All cases of A being B are cases of C being D." The distortion of meaning that is incurred by such change is due to two differences of nature between the Categorical proposition and the Hypothetical. In the first place, the Categorical proposition has, more or less, a reference to actual *existence*; the Conditional proposition, to a necessary *connection*. "If the sea dries up, the fish will fly" will have to be turned into "All cases of the sea drying up, etc."

The latter implies as if there are such actual cases; but the conditional proposition has no such implication. Secondly, the subject of a Categorical proposition is generally an *individual* or group of individuals and the predicate indicates qualities; but in a Hypothetical proposition, the connection refers to *qualities*. For example, "If you go up into the air five miles, you will die for want of air" only states the relation between a particular height, and absence of air, and death. It is not, therefore, advisable, even if it were possible, to change Hypothetical propositions into the Categorical form.

(6) Import of Disjunctive Propositions

Similarly, by the import of Disjunctive propositions is meant the question whether they are different from Hypothetical propositions. It is possible to change a disjunctive proposition into two or more Hypothetical propositions without any loss of meaning; but there is no propriety in so doing, for the oneness of the disjunctive proposition is unnecessarily disturbed. There is, however, another question that is raised in connection with the import of disjunctive propositions; and that is, whether the disjunction in the disjunctive proposition is *complete* or *partial*. Mill, Jevons, etc. hold the latter view. According to them, if one alternative is denied, the other must be affirmed; but if one is affirmed, the other cannot necessarily be denied. 'He is either a fool or a knave' *does* mean that 'if he is not a fool, he is a knave' and 'if he is not a knave, he is a fool:' but not necessarily 'if he is a fool, he is not a knave' or if he is a knave,

he is not a fool,' because, it is argued, he may be both. But if there is a third possibility of his being both a fool and a knave, it should be added as a third alternative and the proposition should be, "He is either a *fool* or a knave or both." Of course, in practice, we do not make the *disjunction complete but leave it one-sided*; but, theoretically, the disjunction should be complete, and alternatives should be made quite exclusive and exhaustive by reference to the context. - A disjunctive proposition should amount to two hypotheticals. If the exclusion is partial, it amounts to only one hypothetical. "Either A is B or C is D" should be equal to (1) If A is B, C is not D and (2) If A is not B, C is D; if the exclusion is partial it amounts only to the second. *The disjunctive proposition is thus an advance* on the hypothetical.

Questions on Chapter IV

(1) Explain the three well-known views regarding the import of Categorical propositions and point out their merits and defects.

(2) What are the consequences, for Logic, of the class-view of the import of Categorical propositions. ?

(3) Why is it not advisable to change Hypothetical propositions into Categorical ones ?

(4) In what sense is the Disjunctive proposition an advance on the *Hypothetical* ?

CHAPTER V

THE LAWS OF THOUGHT

(1) Nature of the Laws of Thought

So far we have studied the *elements* of reasoning. Now we should turn to the *principles* on which correct reasoning is based. These principles are called the "Laws of Thought." The word 'Law' however, is used in a variety of meanings and it is necessary to clearly understand its meaning in the "Laws of Thought." In the first place, by laws are often meant the commands or orders passed by persons in authority to their subordinates, to be obeyed by them, and enforced on them by means of appropriate punishments. The Civil and Criminal Laws of a country are merely the laws codified by government for purposes of the administration of justice. Such laws very much differ from country to country and in the same country from time to time. Sometimes they are dictated by expediency, and sometimes even by whim. They are, therefore, both changeable and violable—changeable according to the degree of civilisation etc; and violable in the sense that they deserve to be violated if they are tyrannical, and are often actually violated through ignorance or passion. The Police regulations

about the rule of the road and Municipal Rules regarding committing nuisance, etc. are illustrations of such kinds of laws. Secondly, the word 'law' means, as in science, not an order or command but an actual observed 'uniformity of behaviour.' The so-called Laws of Nature like that *of Gravitation* or Newton's famous Laws of Movement are Laws in this sense. Such laws are, from their very nature, Inviolable because if a law is violated, it is not a Law at all; for instance, if elliptical movement is the law of planetary motion, but some planets do not follow this law, then the law will have to be changed. So, in the growth of human knowledge, these 'Laws of Nature' may be changed; but so far as they are correctly ascertained, they are unbroken. Even in the sphere of thought, there are laws, of this nature established by psychology. (3) Thirdly, there are 'laws' in the sense of 'Rules,' as of a game. These are merely conventional. So long as one wants to play the game, one has to observe the rules of the game and obey the umpire's decision unquestioningly. But the rules might be changed any time according to convenience or mutual understanding. So, such laws or Rules are also both changeable and violable; but for the time-being they ought not to be violated. (4) Lastly the word 'Laws' is also applied to *Ideals*. What is the Moral Law? It is an ideal way of behaviour. Similarly, the Laws of Aesthetics are the standards of Beauty. The Laws of Thought, as Logic recognises them, belong to this category. The Laws of perfect Conduct, perfect Beauty, and perfect Reasoning are norms or Ideals; and they remain permanent, unchangeable and *inviolable in spite of the fact that none can attain them* completely. Such laws or Ideals are unchangeable

because they are incapable of change, being perfect: and they are inviolable, not in the sense that they cannot be violated like the laws of Nature, but in the sense that they *ought* not to be violated if the particular activity is to be possible. For example, perhaps there is none who has never actually violated the laws of perfect thinking. They are very easy to violate as is shown by the number of fallacies that are constantly committed. There is no force that makes them binding upon us except the force of the Ideal. If a painter breaks the laws of Beauty, who is going to punish him? But if he wants to be a real painter, he cannot break the laws. Similarly, if a person refuses to reason according to the Laws of Thought, none can force him to do so; but one cannot disobey these Laws and yet reason correctly. In all correct reasoning, the Laws of Thought are implicity and unquestioningly obeyed.

(2) Formulations of the Laws of Thought

These fundamental Laws of Thought are formulated in the form of three Laws, viz. (1) The Law of Identity, (2) The Law of Contradiction (which should better be called Law of Non contradiction) and (3) The Law of Excluded Middle. They are frequently stated in the following manner:—(1) A is A (2) A cannot be A and not-A (3) Everything is either A or not-A.

Stated in this way the laws appear to be mere tautologies. But their deeper meaning is the insistence on the consistency of thought. The Law of Identity lays down that a proposition (or a term) must have one and the same meaning in one and the same reasoning. If there is no identity of meaning, there cannot be any

correct reasoning. It does not mean that anything for ever remains what it is, that there is no change at all. What it means is that in spite of change, when a thing is being thought about, it must continue to have the same meaning. For example, the word 'post' may be applied to different things, but at a time it must mean one thing, and not another. The three laws are not different, but are merely different ways of emphasising the great necessity of maintaining the consistency of thought. The Law of Contradiction is a negative way of expressing the same necessity. It says that a thing cannot be different from itself, that is, a thing cannot have and not have the same quality, at the same time, in the same sense. Two opposite statements cannot both be true at the same time. This is nothing more than saying that one cannot blow hot and cold in the same breath, or that one cannot eat the cake and have it. As in the case of the Law of Identity, so here, it must be pointed out that the Law of Contradiction does not mean that a thing cannot have more than one quality or even two opposite qualities. All that it says is that it cannot have them all at the same time, and in the same sense. A man who is asleep can be awake, but cannot be thought of as awake and asleep at the same time. The shield may be white on one side and black on the other; but it cannot be both white and black, in the same part. A person or a thing might actually so change that he or it may acquire just the opposite quality, but he or it cannot be thought to possess the two opposite qualites at one and the same time. The angry man may cool down; but when he is angry, he is not cool. Two opposite or inconsistent predicates cannot be applied to the same thing. The Law of Contradiction is applicable not

pressed it thus, "Everything must have a sufficient reason why it is so and not otherwise." From the point of view of deductive reasoning this means that every proposition presupposes premises or previous propositions with which it is connected as conclusion; from the point of view of inductive reasoning, it means that nothing happens without a cause. This Law also draws attention to the fundamental truth that thought forms a connected system, and is thus an expression of the Law of Identity. As the Laws of Thought are the Laws of *clear* and consistent thinking, *Hamilton adds* one more, to emphasise the clearness, viz. "Logic should be allowed to make *explicit* in *words what is implicit* in *thought*". It is not necessary to lay down this rule as it is a rule about *the expression* of thought rather than about thought itself. It is according to this postulate that we take the liberty to express statements in their logical form. But it is possible to over stretch the limits of this rule, as Hamilton himself does by his 'quantification of the predicate.'

(3) Validity of the Laws of Thought

Now, can these Laws be *proved?* and if not, why should they be binding? The answer to this question is to be had in the *nature* of these Laws, indicated at the beginning. The Laws are in the form of *Ideals*, so that if they are broken, thinking worth the name cannot be carried on. They are sometimes said to be self-evident or axiomatic, like mathematical Laws, such as "Things equal to the same thing are equal to one another" etc. But they are really not quite easily seen. Sometimes it is maintained that they are generalisations or inferences from experience, that is, based on actual

experience. But this view would be quite wrong. Are mathematical laws (like the one stated above), which are similar to the Laws of Thought, based on the actual uncontradicted experience of their working? Is it not more proper to say that actual experience or inference is possible because they are true? Moreover, things may not actually be seen to be identical and permanent; but *to think* about them, they must be taken as unchanged. In short, the Laws of Thought are *postulates* or necessary assumptions underlying all reasoning, experince, and proof. They might have been *formulated* by Aristotle or later logicians; but they must be in operation whenever thinking is carried on. Without them, experience or knowledge would be impossible. They cannot be proved, because they are beyond proof and are themselves the underlying grounds of all proof. They are ultimately reducible to one great principle of "the *systematic* nature of thought and things", that is, things and thought about things cannot be a chaos but must form an orderly and systematic univerese. This principle must be *assumed*; and it requires no proof, because to deny it would be to deny all possibility of knowledge and reasoning.

Note on the Distribution of Terms in a Categorical Propositioo

For purposes of inference it is necessary to know the distribution of terms in a categorical proposition, as practically, the rule of inference is this that a term undistributed in a given proposition, or set of propositions, cannot be distributed in the conclusion based on that proposition or set of propositions. A term is said

Questions on Chapter V

(1) *In which different senses is the word* '*Law*,' used? Clearly distinguish the meaning of '*laws of thought*' from other laws. In what sense are the Laws of Thought unchangeable and inviolable?

(2) Explain the three well-known Laws of Thought and show how they are not really different from one another. In what ways are the Laws misunderstood? Mention the additions made to these Laws.

(3) Can the Laws of Thought be proved? If not, why should they be relied upon?

(4) (*a*) Explain the distribution of terms in the four-fold scheme of categorical propositions.
(*b*) Distinguish between a distributed term and a distributive use of a term.

to be *distributed* when it is taken in its entire denotation, and undistributed when it is not so taken. The *distribution of the subject-term in the four forms* can be easily known as the quantity-mark is given to the subject. Thus, Universal Propositions (A and E) distribute their subjects and Particular Propositions (I and O) do not distribute their subjects. The distribution of the predicate-term will have to be decided by means of the *quality* of the proposition. From the mere form, the predicate-term of an affirmative proposition is undistributed as it might refer to only a part of the denotation. In "All men are mortal' or 'Some men *are honest*, ' the class of 'mortal' or 'honest' beings is not taken in its entirety. But in *Negative propositions*, the *predicate* term necessarily means the whole extension. 'No birds are mammals' or 'some men are not honest' refers to the whole class of 'mammals' or 'honest beings.' Thus the results may be summarised as follows :—

In A,	subject is	distributed,	and predicate	undistributed
,, E,	,,	,,	,,	distributed
,, I,	,,	undistributed	,,	undistributed
,, O,	,,	,,	,,	distributed

The doctrine of the *distribution* of terms ought not to be confused with the theory of the *distributive* use of a term. The former refers to the extent of extension, the latter to the mode of using a term. A distributed term need not be a distributively used term. For example, in "All the sailors saved the passengers," the subject-term is distributed, but not distributively used. On the other hand, an undistributed term may be distributively used. For example, in "Some students passed the examination," the subject-term is undistributed but used distributively.

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CHAPTER VI

IMMEDIATE INFERENCE

(A) Opposition of Propositions

(1) Meaning of Inference

Inference is the process of passing from a given proposition or propositions or from an observation (of which experiment is the better type) of facts, to a *new* proposition. The former is called deductive inference and the latter inductive inference. The material with which the mind starts is the *data*, and the new proposition is the conclusion. Deductive inference, again, is Immediate or Mediate, according as the data consist of only one proposition or of more than one proposition (which are called premise or premises). The difference between Immediate and Mediate inference is not, therefore, a difference of time required, but of the data. A Mediate inference may be very quickly drawn, as, for instance, the inference—

All men are mortal
Socrates is a man
∴ Socrates is mortal.

On the other hand, an Immediate inference might involve a complicated process, as in

All wise men are happy;
∴ All persons that are not happy are persons that are not wise.

Immediate inference may, therefore, be defined as an inference in which, from a given proposition, a new proposition is arrived at, which is necessarily implied in the former. There are various ways of doing so. But they may all be summed up under three heads, viz., (1) *Opposition* of propositions (2) *Eductions* and (3) Other, processes like *Converse Relation* etc.

(2) Opposition of Propositions

By 'opposition of propositions' is meant the relation between two propositions having *the same subject and predicate*, but differing in quantity or quality or both; and by "inference by opposition" is, therefore, meant inference, from the given truth or falsity of a proposition, of the truth, falsity or doubtfulness of another proposition having the same subject and predicate, but differing in quantity, quality or both. The word "opposition" is here used in a *technical* sense; for two propositions which are *materially* opposed like the propositions, "Mr. Bose is the President of the Indian Congress" and "Mr. Rajendraprasad is the President of the Indian Congress" are *not logically* opposed because they have not got the same *subjects*. Similarly, "This paper is white" and "This paper is brown" are not logically opposed because they have not got the same *predicate*, though they have the same subject. On the other hand, two propositions like "All men are selfish" and "some men are selfish" *are* logically opposed, though they are not materially opposed at all. In this technical sense, there will be three possible forms of opposition

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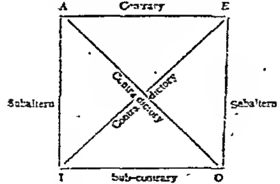
between two propositions, viz. (1) When they differ in both quantity and quality. (2) When they differ only in quality and (3) When they differ only in quantity. The first of these is called '*Contradictory opposition.*' There will be two pairs of contradictory propositions :— A—O and E—I. When they differ only in quality, that is, when one is affirmative and the other negative, if they are both universal, the opposition is called *contrary opposition.* Thus A and E are contraries ; when they are both particular, it is called *subcontrary opposition.* Thus I and O are subcontraries of each other. Lastly, when they differ only in quantity, the quality remaining the same, it is said to be *subaltern opposition.* There will be two such pairs :—A—I and E—O. Of the two propositions in subaltern opposition, the universal is called the *subalternant* and the particular is called the *subalternate.* Thus there are altogether *four relations by opposition* between two propositions :—(1) Contradictory (2) Contrary (3) Subcontrary and (4) Subaltern. These four forms of opposition are shown by means of a diagram which is called the "*Square of Opposition.*"



By means of the forms of opposition, it will be easy to infer, from the truth or falsity of one proposition, the truth, falsity or doubtfulness of another proposition having the same subject and predicate.

(3) Rules of Inference relating to "Opposition"

(i) *Contradictory propositions cannot both be true and cannot both be false*; that is if one is true, the other must be false: and if one is false, the other must be true. Both cannot be true on account of the Law of Contradiction. For instance, if we are right in affirming that 'All men are mortal,' how can we deny mortality to some men, in the same breath? Therefore, if 'All men are mortal' (A) is true, "Some men are not mortal" (O) must be false. Similarly, E and I cannot both be true. Again, both cannot be false, on account of the Law of Excluded Middle. For instance, if it is false to say that "All Students have passed" it must be true to say that "Some (i. e., some at least) students have not passed." Out of two opposite predicates 'passing' and 'not passing,' one *must be* applicable, so that if one is denied the other must be affirmed. It should be carefully remembered that to contradict a proposition means to deny it. The least flaw in the given proposition is enough to refute it; that is why a *universal* affirmative is contradicted by a *particular* negative and a *universal* negative by a *particular* affirmative.

(ii) *Contrary propositions* (A-E.) *cannot both be true*: that is, if one is true, the other is false: but if one is false, the other need not necessarily be true but *may* be false, and so, is *doubtful*. This follows from the Law of Contradiction. Two opposite things cannot both be

affirmed of the same subject. If "All students have passed" is true, "No student has passed" must be false. If that is also true, then, we shall be both affirming and denying the same quality, 'passing' of '*All students*.' But both may be false. If 'All students have passed' is false, 'No students have passed' need not necessarily be true, because some students might have passed, and some not passed. Contrary propositions do not merely deny each other, but affirm something more. Hence they may both be false. Contradictory and contrary are the most important of the oppositions as they are real oppositions. So Aristotle restricted opposition to only these two.

(iii) Subcontrary propositions (I-O) cannot both be false, but may both be true. This follows from the Law of Excluded Middle. If it is false to say that "Some students have passed," it must be true to say that "Some students have not passed;" because, out of the two opposite qualities of 'passing' and 'not passing,' one must be applicable to the same subject, 'some students'; so that if 'passing' is denied, 'not passing' must be asserted. But both may be true; for even if both are true, the law of Excluded Middle is not violated. It is possible to say that 'some students have passed' and 'some students have not passed'. The two opposite qualites of 'passing' and 'not passing' are not here applied to the same subject, because though the subject is outwardly one viz. "some students," it is not really the same because it may refer to *two different* sections of students, each designated as 'some students.' So from the falsity of one of the subcontraries, the truth of the other can be inferred, but from the truth of one, nothing can be inferred about the other. The same result may be shown in another way. If I is false,

its contradictory E must be true; and if E is true, O must be true (as will be shown from the nature of subaltern relation). So if I is false, O is true. Similarly, if O is false, I is true.

(iv) Subaltern Propositions may be inferred from one another, on the law of the distribution of terms, namely, that if a term is undistributed in the premise, it cannot be distributed in the conclusion, but if it is distributed in the premise, it can remain undistributed in the conclusion. So the following four rules will follow.—(1) If the subalternant (A or E) is true its subalternate (I or O) must be true. (2) If the subalternant is false, the subalternate remains unknown; because though a predicate is denied of the whole class, it is not necessarily denied of a part of the class. (3) If the subalternate is true, the subalternant is unknown, because there is no warrant to apply to the whole class what is applicable to a part. (4) If the subalternate is false, the subalternant must be false. For if a predicate is denied of a part, it is a *a fortiori* denied of the whole.

Subcontrary and subaltern oppositions are not strictly oppositions because the two propositions (I and O; or A and I) can be true together.

With regard to the Singular propositions, it should be noted that their contrary and contradictory are the same. For example, of "Socrates was wise," "Socrates was not wise" is the contrary as well as the contradictory. As Socrates is one undivided individual, the denial must apply to the whole.

An ingenious Square of "Tables of Opposition" has been devised to facilitate the remembering of these inferences, as follows:—

T	F	T	F
A	E	I	O
E	A	O	I
I	O	A	E
O	I	E	A

D

[First, a big square with 16 places should be drawn. Then, letters 'A' and 'O' should be diagonally written. The other places should be filled up (by starting with A) in the order of A, E, I, O. The letters T and F should be alternately written at the top; and at the bottom, an inner square should be thickly marked as shown in the diagram and marked D. By looking to the T or F side of any proposition, we can, by means of the Square, find the T (True) F (False) or D (Doubtful) of the opposed propositions]

These inferences are based on the usual interpretation of 'some' as 'some at least—may be, all.' But if 'some' is to mean 'some only,' the inferences will be considerably affected.

If I is true,	A	will be	*false* and not doubtful.
and	O	,,	*true* and not doubtful.
If I is false,	A	,,	*doubtful* instead of false.
and	E	,,	,, ,, true
If O is true,	E	,,	*false* instead of doubtful
and	I	,,	*true* ,, ,,
If O is false,	A	,,	*doubtful* ,, true
and	E	,,	,, ,, false

To contradict or refute a proposition is merely to deny its entire truth. The Contrary asserts something more besides denying the given proposition. This distinction between the two should not be overlooked. It is

often lost sight of in anger created by the heat of discussion, and the angry man suffers thereby in the argument. If the proposition, "All men are wise" is to be denied, it is enough to point out that some, or even one, man is not wise; it is not necessary to show that none are wise.

(4) "Opposition" of Conditional Propositions

The Contradictory opposition is the most fundamental as it enables us to argue both ways—from the falsity or truth of one, to the truth or falsty, respectively, of the other, of the Contradictory propositions. It is necessary to know how to contradict the Conditional propositions. The Hypothetical proposition, as it states a connection between an antecedent and its consequent, is contradicted by denying that connection, that is, by retaining the antecedent but denying the *consequent*. The *contradictory* of 'If A is B, C is D,' would be, 'If A is B, C is not D,' and not, "If A is not B, C is not D." "If a metal is heated it expands" is contradicted by "If a metal is heated, it does not expand."

If there is a Conjunctive proposition, that is two propositions put together, it is enough to deny them *disjunctively*. "He earned a good deal of money and built a house" is contradicted by "Either he did not earn a good deal of money or did not build a house." To deny both conjunctively would be to give the Contrary. Lastly, a disjunctive proposition is contradicted by a Conjunctive denial of the alternatives and not by a disjunctive denial. The Contradictory of "Either A is B or C is D" is "A is not B *and* C is not D" and not "Either A is not B or C is not D." The importance

of framing the correct contradictory of a disjunctive proposition will be understood when the nature of the dilemmatic arguments will be considered. "He has either taken Logic or Mathematics" is not denied by saying that "*He has either not taken Logic or not taken* Mathematics" because this would be saying the same thing and not denying it. The proper denial is to say, "He has neither taken Logic nor Mathematics." In short, the conjunctive proposition is contradicted by a disjunctive proposition and a disjunctive proposition is contradicted by a conjunctive proposition ; and a hypothetical proposition is contradicted by denying the consequent.

(B) Eductions

(5) Difference between 'Opposition' and 'Eduction

In opposition of propositions, we do not actually infer another proposition from a given one ; but being given two propositions with the same subject and predicate we determine their mutual implication with regard to truth and falsity. In 'opposition,' there is no change made in the subject or the predicate term, or in their places. But, by means of the Laws of Thought we can substitute, for the orginal subject or predicate, its contradictory term, or can interchange the subject and predicate, and yet retain the same meaning. This process *of inferring from a given proposition* another proposition by interchange of the subject and predicate, or by using their contradictories may conveniently be called "*Eduction.*"

(6) Kinds of Eductions.

Assuming that S and P are two classes and 'not-s' and 'not-P,' sometimes indicated by $\overline{S}$ and $\overline{P}$, are the

opposite classes, the maximum number of propositions we can get from S - P will be *seven*, viz.

(1) P—S (called Converse),
(2) S—not-P („ Obverse)
(3) P—not-S („ Obverted Converse)
(4) not-P—S (Contrapositive or Partial Contrapositive)
(5) not-P—not-S (Obverted or full Contrapositive)
(6) not-S—P (Inverse or Partial Inverse)
(7) not-S—not-P (Obverted or full Inverse)

Let us see how to obtain these seven types of immediate inference from each of the four forms of Categorical propositions.

(7) The Converse

Converse is the inference, from a given proposition, of a new proposition in which the original subject and predicate are interchanged. The original proposition is called the *convertend*, and the process is called *conversion*. From an affirmative proposition which states an inclusion of S in P, we can infer the inclusion of P in S. Similarly, from a negative proposition which states an exclusion of S from P, we can conlude to the exclusion of P from S. In the converse, therefore, the *quality* of the original proposition must remain unchanged; but we cannot say the same about the quantity. An important practical rule of inference is this, that no term which is undistributed in the premise can be distributed in the conclusion, as that would be going beyond the evidence. Now, in an E proposition, "No S is P," what is stated is that no part of S is included in any part of P. There-

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fore, we can say that no part of P is included in any part of S, that is, "No P is S" (E). Similarly, in an I proposition, "Some S is P," *some part at least* of S is said to be included in P, so that, *some part at least* of P is common with S, that is, "Some P is S" (I). In the converse of E or I we have *only* to interchange their places without changing the quantity. Such a converse is called 'Simple Converse.' But, given an A proposition we cannot convert it simply. If all S is included in P, for ought we know, it might form a part of the larger class P. So all P is not coextensive with S, but at least some part of P is S, that is, "Some P is S" The term P is undistributed in the original proposition and it must remain undistributed in the converse where it stands as the subject. So, logically, (that is, from the mere form of the proposition) we cannot convert an A proposition *simply*, but '*by limitation*' or '*per accidens*', which gives an I proposition. For example, it would be wrong to infer from "All men are animals" that "All animals are men" or from "All Englishmen are Europeans" that "All Europeans are Englishmen". In geometry, however, by the converse of a *theorem* (which is always an A proposition) is meant another A proposition with the original sides changed. But because such a universal proposition does not follow *logically*, it has to be stated as a new theorem and proved. *However*, if the predicate-term (which is to become the subject) in the original A proposition is a Singular term, the proposition can be converted simply, because then there would be no violence to the distribution of terms. For example, "Socrates was the wisest man in Greece" is correctly converted into "The wisest man in Greece was Socrates." Turning to the O proposition which states

that at least a part of S is excluded from P, we cannot say that some or all of P is excluded from S, because S might be a larger class of which P is a part. Technically, the S term, originally undistributed, will be distributed in the attempted converse (Some P is not S). Hence, an 'O' proposition has, logically, no converse. For example, from "Some animals are not men" it would be wrong to conclude that "Some men are not animals." This does not mean, however, that the converse of an O proposition is always materially false. For example, "Some graduates are not teachers" and "Some teachers are not graduates" are both true: but neither follows from the other *logically*. They are true because they are separately known to be true. To summarise: An A proposition can be converted, not simply, but by limitation, giving us an I as converse. E and I propositions can be converted simply; and an O proposition cannot be converted at all. It may also be noted that if we convert the converse, we get back to the original proposition in the case of E and I but not in the case of A.

(8) The Obverse

The second main form of eduction depends on the the general principle that every proposition can be expressed either affirmatively or negatively. The process of turning an affirmative proposition into its negative equivalent or vice versa is called obversion. It is called 'Immediate Inference by privative conception,' by Jevons, and 'permutation' by some other logicians. The original proposition is called the obvertend and the conclusion, the obverse. In obversion we infer exclusion from inclusion or inclusion from exclusion. It is the application of the Law of Excluded Middle, for if S

is included in P, it must be excluded from the opposite class, 'not-P', and if excluded from P, it must be included in 'not-P'. As obversion involves the use of contradictory terms, it may be defined as an immediate inference by using the contradictory opposite of the original predicate as the new predicate. The quantity of the proposition does not change; the quality is changed to retain the original meaning, as the new predicate is the contradictory of the old one. Thus we get the following obverses :—

From (A) — All S is P — (E) No S is not-P.
" (E) — No S is P — (A) All S is not-P.
" (I) — Some S is P — (O) Some S is not not-P.
" (O) — Some S is not P—(I) Some S is not-P.

If we obvert these obverses, we again get the original propositions in all cases. All the four types of propositions yield the obverse. In each concrete case, the real contradictory of the original predicate must be ascertained by reference to the context. Very often, the contradictory is best formed by using the words 'other than' before the original predicate-term; for example, "Caesar is our king" is obverted into "Caesar is not other than our king." It is the obverse that is used, when we emphasise our meaning by denying its opposite. "He is awake" may be re-told by "He is not asleep."

(9) The Contrapositive and the Inverse

It has been seen that there is no gain in converting the converse or obverting, the obverse, of a proposition because we get back to the original proposition. If, therefore, a new proposition is wanted, the converse and obverse (which are called primary eductions) must be practised alternately. The Eductions that we thus obtain are called derivative eductions, of which there

will be these forms :—(A) *Obverted Converse,* which, as the phrase indicates, is obtained by obverting the converse. For the same reasons that hold for conversion, an O proposition will have no obverted converse, and A will have a limited (i. e. particular) obverted converse. (B) *By converting the obverse we get 'not-P' as the* subject, and S as the predicate, which is the *contrapositive* (Partial). If for S, we want 'not-S' as the predicate, the partial contrapositive should be obverted. The I proposition will have no contrapositive because there can be no conversion of O into which it is first turned by obversion; but O will have the contrapositive. It should be noted that the full or obverted) Contrapositive of A is another A proposition with the contradictories of the original predicate and subject standing as the new subject and predicate respectively. (C) To get the inverse (that is, the opposite of the original subject as the new subject) we have to repeat the processes till we arrive at the required subject. It must be remembered that, in the case of A, we must begin with the obverse as otherwise we shall be confronted with an O proposition requiring conversion. With E, a start with conversion gives the inverse very soon. As, in getting the inverse from A or E, one cannot help, at some step, the converse of an A proposition, the inverse obtained is a particular proposition in each case. Similarly, in trying to obtain the inverse of I or O, the converse of 'O' offers an insurmountable difficulty, at some step or other; and so there is no inverse of an I or O proposition.

(10) Summary of Eductions

The results thus obtained are given in the following tables :—

TABLES OF EDUCTIONS

Original proposition	Converse	Obverse	Obverted converse	Partial contrapositive	Full contrapositive	Partial inverse	Full inverse
All S is P	Some P is S	No S is not-P	Some P is not not-S	No not-P is S	All not-P is not-S	Some not-S is not P	Some not-S is not-P
No S is P	No P is S	All S is not-P	All P is not-S	Some not-P is S	Some not-P is not not-S	Some not-S is P	Some not S is not not-P
Some S is P	Some P is S	Some S is not not-P	Some P is not not-S	—	—	—	—
Some S is not P	—	Some S is not-P	—	Some not-P is S	Some not-P is not not-S	—	—

Or, more *briefly*,

S A P	P I S	S E $\bar{P}$	P O $\bar{S}$	$\bar{P}$ E S	$\bar{P}$ A $\bar{S}$	$\bar{S}$ O P	$\bar{S}$ I $\bar{P}$
S E P	P E S	S A $\bar{P}$	P A $\bar{S}$	$\bar{P}$ I S	$\bar{P}$ O $\bar{S}$	$\bar{S}$ I P	$\bar{S}$ O $\bar{P}$
S I P	P I S	S O $\bar{P}$	P O $\bar{S}$	—	—	—	—
S O P	—	S I $\bar{P}$	—	$\bar{P}$ I S	$\bar{P}$ O $\bar{S}$	—	—

These Eductions seem formidable, but even the most complicated ones like the Contrapositive and the Inverse may be put down at once by remembering the following few points :—

(1) Out of the 28 places to be filled up, 8 will be blank, I and O having no inverse, (partial or full), and I having no contrapositives and O having no converse and obverted converse.

(2) Out of the 20 propositions, (A and E having 7 each and I and O having 3 each) only 6 will be universal propositions viz. the obverse and two contrapositives of A, and the converse, obverse and obverted converse of E. All the rest (14) will be particular propositions. The *quality* in *each* case can be *easily determined*, according to the negatives applied, with a view to retain the original meaning. The converse, full contrapositive and full inverse have the same quality as the original proposition. The rest have the opposite quality.

(11) Practice in Eductions

Now, some practice may be undertaken. It is of the utmost importance to look to the form of the proposition given and to put it into logical form before any inference is attempted.

1 Mercy but murders, pardoning those that kill.

In logical form=All mercy, pardoning those that kill, is a murderous thing (A)

Converse (by Limitation) = Something murderous is mercy, pardoning those that kill. (I)

Obverse = No mercy, pardoning those that kill, is other than murderous. (E).

Contrapositive (partial) = Nothing other than murderous is mercy, *pardoning those that kill* (E).

Inverse (partial) = Some things other than mercy are not murderous (O)

2 Only *Protestant kings can sit* on the *throne* of England.

This is an exclusive proposition and best put in the form of E; but for purposes of inference it is more convenient to take it in its A form thus:—

"All kings that sit on the throne of England are Protestant," and then the eductions should be proceeded with.

3 *Pure* eduction is not so *difficult* to manage as the combination of eduction with opposition of propositions, as in *the following question*:—

Determine the logical relation between, and the validity of inference from (1) All crystals are solids, of (2) Some solids are not crystals and (3) Some non-solids are not crystals.

Answer: As the subject of the second proposition is the predicate of the first, it must be the converse. But the actual convetse of (1), would be "Some solids are crystals." So, the second proposition is the subcontrary of the converse: and if the first proposition is true, the second proposition is doubtful.

Similarly, "Some non-solids are not crystals" (proposition *No 3*) *as related to* (*1*) *must be the partial* contrapositive, as the opposite of the original predicate is made the new subject; but the actual *contrapositive is a* universal proposition, "No non-solids are crystals," of which, proposition No 3 is the subalternate. Hence, it is

he subalternate of the partial contrapositive of proposition No. 1, and must be true, if the latter is given to be true.

(4) What is the logical relation between the following propositions? (1) Heat expands bodies (2) Cold contracts bodies.

Answer: Here apparently the opposite predicate is applied to the opposite subject and actually science has demonstrated the truth of both these statements. Proposition No 2 is, therefore, called the "Material obverse" of proposition No 1. However, if we look at it strictly logically, it might be called an attempt at inverse. As inverse, however, it is incorrect for two reasons:—(1) In the first place, 'Heat' and 'cold,' and 'expanding bodies' and 'contracting bodies' are not strictly contradictory terms but only contrary terms. The eductions are based on contradictory terms. (2) Secondly, even granting, for argument's sake, that they are contradictory terms, the inverse cannot be a universal proposition but a particular one.

(C) Processes of Immediate Inference, other than 'Opposition' and 'Eduction'

(12) Immediate Inference by Added Determinants and by Complex Conception

Looking at the subject and predicate of a proposition as two balancing sides, it is possible to retain the balance by adding the same weight, so to say, to both sides, and thus have a new proposition. If the same adjective is added to both sides, it is called inference by *added determinants*; and if any other phrase is applied, it is called inference by *complex conception*, as, thereby, the

subject and predicate terms are made more or less complex. The following will serve as illustrations of the two kinds of inferences :—

(1) "All Negroes are men ;" therefore, " All honest Negroes are honest men." (Inference by added determinants).

(2) "All bees are insects ; " therefore, " All wings of bees are wings of insects. " (Inference by complex conception).

Provided the *qualifying adjective or phrase* has precisely the same meaning in both the places, such inferences are perfectly correct. But often they are fallacious because the same quality or phrase does not modify the predicate exactly in the same sense or to the same extent as it modifies the subject. For instance, " An ant is an animal ; ' therefore, ' A big ant is a big animal ' " is an *incorrect* inference by added determinants, because, the quality ' big ' as applied to the wider class of ' animals ' carries a different notion from when applied to ' ant. ' It would be correct to say that "a big ant is big as an ant" but then there is no point in making such an assertion. Similarly, because a carpenter is a man, we cannot argue that a bad carpenter is a bad man; for though bad as a carpenter he may be very good as a man ; nor can we infer by complex conception from " Englishmen are Europeans " that " Majority of Englishmen are majority of Europeans. "

(13) Immediate Inference by Converse Relation

Another very common mode of inference is based on the fact that the relation between subject and predicate may be of a more definite nature than mere inclusion or

exclusion. In such cases, if the same relation is looked at from the side of the other thing or person, a new proposition is obtained. As the sides are changed this is called "inference by converse relation." There are various sorts of relations, chiefly, relations of (1) Space (2) Time (3) Quantity (4) Quality and (5) of Blood. An example of each is given below:—

(1) A is to the *north* of B
Therefore, B is to the *south* of A

(2) A died *before* B
Therefore, B died *after* A.

(3) A is *larger* than B.
Therefore, B is *smaller* than A.

(4) A is *better* than B
Therefore, B is *worse* than A.

(5) A is the *father* of B
Therefore, B is a *child* of A.

The validity of an inference by converse relation depends upon the exactness of the knowledge of the reciprocal relations in that particular system. For example, from "A is the brother of B," we cannot say that "B is the brother of A" because the relation as sister is possible. Therefore, we must say, "B is the brother or sister of A."

Inference by converse relation must be distinguished from the converse. In the latter, it is the subject and predicate terms that are changed; in the former, it is the *relation* that is changed. To illustrate: "A is greater than B" becomes by converse "Something greater than B is A," but by converse relation, it becomes,

"B is smaller than A", There is a difference between the subject-terms of the two conclusions.

Besides these types of inference many others are possible; but as there is nothing in them that cannot be reduced to the above mentioned types, they need not be separately designated. For instance, the change of active voice into passive is a sort of converse relation. "Brutus killed caesar" will yield "Caesar was killed by Brutus." Even the modality of a proposition may be made the basis of immediate inference. From this point of view, it is shown that from an apodeictic proposition, an assertoric one may be inferred; and from an assertoric one, the problematic can be inferred; but not vice versa.

(14) Concluding Remarks

Immediate Inference is criticised as being no inference at all but mere verbal transformation. Such criticism is not, however, correct; because even in Immediate inference we do derive a new proposition. Any change either in the subject or the predicate does give a new proposition. Moreover, immediate inference is of very great practical importance. In legal matters particularly, much depends on the *interpretation* of statements. If the implications of a given proposition are not known, one is likely to be fooled. Two propositions may be logically identical in meaning, though this fact may escape notice. For instance, to declare the names of candidates that have failed at an examination would be logically equivalent to declare the names of those that have passed, but the latter method is always preferred because it is more agreeable. In one of the fables, a king rewarded one

astrologer but punished another though the predictions of both were *logically* the same. One predicted that all the grand-children of the king would die before him; and the other predicted that the king had such a long life that he would survive all his grand-children. It was the failure on the king's part to see the identity of the two predictions that made him treat them so differently. In the technical language of logic, the predictions are inferences by *converse relation* from each other. Similarly, in another story, we are told that a certain king obtained a boon from one of the gods, by which he was assured that he would be killed neither by day nor by night, neither by man, nor by beast, neither in the house, nor outside it, and neither by blows, nor by weapons. The king, thinking that he was free from the clutches of death, became very oppressive, but soon met the punishment of death which avoided the terms of the boon conferred on him. He was killed in *twilight* by a *half-man-half-beast*, on the *threshold*, by being torn by *nails*. Here, in the language of logic, the king's mistake lay in taking contrary terms as contradictory terms. So ignorance of Logic, even in the sphere of the petty immediate inferences, is fraught with danger! Immediate inference is not, therefore, a trivial matter.

Questions on Chapter VI

1 (*a*) Distinguish clearly between contrary opposition and contradictory opposition.

(*b*) Contradict the following assertions :—

(i) All are not saints that go to church

(ii) If A is B, C is D.

(iii) Either A is B or C is D.

(iv) A went mad and committed suicide.

2 Give the converse, obverse, contrapositive and inverse of the following statements:—

(i) Not all the riches of the Earth can bring happiness.
(ii) All the students that are not 'repeaters' are present.
(iii) Humour is not given to all.
(iv) Some men are selfish.

3 State the logical relation between the following propositions (taken two at a time) and show whether the truth or falsity of one can be inferred from the truth or falsity of the other.

(i) No intelligent persons are prejudiced.
(ii) Some unintelligent persons are unprejudiced.
(iii) All unprejudiced persons are intelligent.
(iv) Not every prejudiced person is unintelligent.

4 State, with reasons, what can be asserted as to the truth of a proposition from:—

(i) The falsity of its contrary.
(ii) The truth of its simple converse.
(iii) The truth of its subcontrary.
(iv) The falsity of its converse.
(v) The falsity of its subalternate.

5 Show why we cannot infer from "All A's are B" that "Some B's are not A;" nor, from "Some A's are not B" that "Some B's are not A."

6 Name and test the following inferences:—

(i) A poet is a man, therefore, a good poet is a good man.
(ii) *Blood is thicker than water: therefore, water is thinner than blood.*
(iii) Students work out logic-exercises; therefore, a large number of students work out a large number of logic-exercises.

CHAPTER VII

(A) The Categorical Syllogism

(1) Mediate Inference : The Syllogism

Though immediate inference, as indicated in the last Chapter, deserves to be styled an inference, it is the other type of inference, viz. Mediate inference, that richly deserves that title. Mediate inference is an inference to a new proposition, from *two* or more propositions, by means of a link or connection between them. When the link consists of a common term, the inference is syllogistic, and when it consists in some system of relations, it is non-syllogistic. A Syllogism may, therefore, be defined as a formal statement of the way in which two things or terms are connected together or discriminated from one another, by means of a third thing or term which is common to both. The simplest form of the syllogism is the *Categorical Syllogism*, that is, a Syllogism in which all the propositions are Categorical, as in the following standard example:—

All men are mortal
Socrates is a man
∴ Socrates is mortal.

The Categorical Syllogism thus consists of three propositions of which the two propositions, which are given,

are called the *premises* and the third proposition, which is inferred from the two, is called the *conclusion*. In order that the inference could be drawn, there must be a connecting link or common term between the two propositions, which is called the *middle term*; the remaining two terms being called the *extremes*. The middle term need not be middle in extension, though it is so in the most natural form of the syllogism. It is 'middle' in the sense of being the *connecting* link. Out of the two extremes, the predicate-term of the conclusion is called *the major term* and the subject-term of the conclusion is called *the minor term*. Of the premises, consequently, that which contains the major term is called the *major premise* and that which contains the minor term is called the *minor premise*. The formal manner of writing the syllogism is, the major premise first, the minor premise second, and the conclusion last.

(2) The Principle of the Syllogism

The ruling principle of the Syllogism may be stated in one of three ways according as the predicative, the attributive, or the class-view, of the import of propositions, is held. As stated by Aristotle (who took the predicative view), it was briefly this:—" Whatever can be predicated of a predicate (affirmatively or negatively) can be predicated, in like manner, of its subject." Mill (who takes the attributive view) puts it thus, "The mark of a mark is a mark of the thing itself and what is denied of a mark is denied of the thing itself." According to the class-view, it may be stated thus:—"If a class of things is included in, or excluded from, another class, and itself includes another class, then the last class is included in or excluded from the other class." Or a

combination of the first view and the third may be made and the principle stated thus (as e. g. by Jevons):— "Whatever is predicated of a term distributed, whether affirmatively or negatively, may be predicated, in like manner, of everything contained under it." As thus stated it is called "the dictum de omni et de nullo" or more briefly, the *Dictum* of the Syllogism. The Dictum requires no proof, as it is rooted in the Laws of Thought (which mean that thought and things are systematic), just in the same way as the principle, "Things equal to the same thing are equal to one another," requires no proof, in mathematics. The Dictum yields, directly, *four* forms of the Syllogism (according as the major term is predicated of the middle *affirmatively* or *negatively*, and the middle term is predicated of the minor, *universally* or *particularly*) thus:—

1	2	3	4
All M is P	No M is P	All M is P	No M is P
All S is M	All S is M	Some S is M	Some S is M
∴All S is P	∴No S is P	∴Some S is P	∴Some S is not P

Aristotle's method of testing any deductive reasoning was by discovering whether or not it could be stated in one or other of these four forms (which have all the same structure as regards the connection of middle term with the extremes). But later logicians have devised a simpler method of testing the validity of a Syllogism (whatever be the position of the middle term), namely, by framing a set of rules as following from the Dictum, none of which must be violated if the reasoning is to be valid. They are called the Canons or General Rules of the Syllogism.

(3) The Canons or General Rules of the Syllogism

The General Rules of the Syllogism are eight in all The *first two* are about the *structure of the Syllogism* the next two about quantity, that is, about the distribution of terms; the following two are concerned with quality relations between premises and the conclusion; and the last two are *corollaries following from the preceding Rules.* The Rules are stated thus:—

Rule I: A Syllogism must consist of three and only three propositions.

[Explanation: The propositions must be three: for if they are less than three, they might form an *immediate inference or no inference at all, but not mediate inference*; For example, "some S is P; therefore, some P is S'"—is not mediate inference, that is, is not syllogistic reasoning. Again, if there are more than three propositions, the inference is made up of more syllogisms than one; for instance, 'All S is P, All P is R, All R is Q' yield the conclusion 'All S is Q;' but the whole would make *two* syllogisms and not one.]

Rule II: A Syllogism must have three and only three terms.

[Explanation: This is obvious, as the two premises though they have altogether four terms must have one term which is common, and as the conclusion does not contain any new term but merely repeats the extreme terms. The special propriety of stating this very simple rule lies in emphasising the Law of Identity by which a term must have one and the same meaning in the same discourse; if it has more meanings than one, it is *not one term* at all. In the case of the Syllogism, this

has a special reference to the middle term. If the middle term, even though it might be the same in words, does not carry exactly the same meaning in both the premises, it is not one term but two ; and then there being no really connecting term, the reasoning is viciated. Hence, when this Rule is violated with regard to the middle term, the resulting fallacy is called the "*ambiguous middle*" or "*fallacy of four terms.*"

The following illustrations of this fallacy will impress the importance of this Rule on the minds of budding logicians:—

(1) All metals are elements
Brass is a metal
∴ Brass is an element

This argument is viciated by the double meaning of the so-called middle term 'metals,' which is used once in a scientific sense and another time in the householder's sense.

(2) *Criminal actions must be punished*
Prosecutions for theft are criminal actions
∴ Prosecutions for theft must be punished.

This unwise conclusion is due to the fact that the phrase 'Criminal actions' is used in these two senses:—(i) Perpetration of crimes (ii) Instituting legal procedure with reference to crimes.

When a lawyer carries on a large '*criminal practice*,' he is not to be supposed to be perpetrating a large number of crimes.

(3) What is right must be enforced by law
Charity is right
∴ Charity must be enforced by law.

Here, the word 'right' is used in one place in the legal sense, and in the other place, in the moral sense. It, therefore, amounts to two terms and there are *four terms* in the Syllogism.

(4) Red is a colour
    Blood is red
    ∴ Blood is a colour.

This example illustrates how the least possible change of meaning—even changing the part of speech miscarries the thought.

Rule III: The middle term must be distributed in at *least one of the premises.*

[Explanation: If the middle term is not distributed even once, the major term might refer to one part of the middle term and the minor term may refer to another part. Consequently, there will be no common or connecting term at all.] A breach of this rule is called the "*Undistributed Middle.*" The difference between Rule III and Rule II is this that Rule III does not contemplate a double meaning of the middle term, but its being undistributed, even though it might mean exactly the same thing in both the premises. If this Rule is not observed, almost anything can be proved to be any other thing.

The following illustrations of the fallacy will make this clear:—

(1) All horses are animals
    All men are animals
    ∴ All men are horses.

The absurd conclusion is due to the fact that horses form one part of animals, whereas, men form

altogether another part of animals, thus leaving no connecting term, on account of the middle term not being distributed.

(2) B is wise.
. A is wise.
∴ A is B.

Here again, as wisdom is not the monopoly of one person, from the fact of wisdom being possessed by two persons, we cannot conclude identity of the two persons.

If the middle term is distributed in both the premises there is no harm; but the minimum necessity for validity is one distribution.

Rule IV: No term can be distributed in the conclusion, unless it is distributed in the premise.

[Explanation: This Rule applies to the major and minor terms which are the two terms of the conclusion. It is obvious that if they are distributed in the conclusion without being distributed in the premise, we shall be going beyond evidence. But the rule does not apply the other way. A term distributed in the premise may remain undistributed in the conclusion. A breach of this rule, in its application to the major term, is called an "Illicit process of the major term" (or 'Illicit major'); and as applied to the minor term, it is called the "Illicit process of the minor term" (or 'Illicit minor')].

The following examples will serve as illustrations of the fallacies:—

(1) He who is content with what he has is truly rich;
A covetous man is not content with what he has;
∴ No covetous man is truly rich.

The conclusion does not follow from the given premises, *because the term 'truly rich persons,' is not referred* to in its entire denotation in the major premise (that is, is not distributed) and therefore cannot be taken in its entire denotation in the conclusion. There is thus the *fallacy of the "illicit process of the major term."*

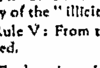
(2) All books *are subject to error* ;
All books are of man's invention ;

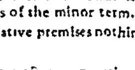
∴ All things of man's invention are subject to error.

Here the conclusion is invalid because it refers to the whole extension of the minor term, 'things of man's invention,' though the *whole extension is not* thought of in the minor premise. Thus there is a fallacy of the "illicit process of the minor term."

Rule V: From two negative premises nothing can be inferred.

[Explanation: If both premises are negative, there is no necessarily common ground between the major term and the minor term. If both of them are excluded from a third term, we are left in doubt about their mutual *exclusion. Both the following diagrams represent* the two premises, 'No M is P' and 'No S is M':





and yet, S and P are entirely excluded from each other in the first case, but not so in the other. So, no conclusion can be drawn when the premises are negative.]
However, we must guard against the mistake of judging

the validity merely by means of the quality of the premises. Particularly, if the middle term is itself a negative term, the two premises, when obverted into their corresponding affirmative forms will still have a middle term and will give a valid conclusion, other Rules being observed. The following examples illustrate how two apparently negative premises yield a valid conclusion.

(1) What is invisible cannot be trusted
Ghosts are not visible
∴ Ghosts cannot be trusted.

The conclusion is quite valid, because though both the premises are negative when considered separately, the middle term 'invisible' will be available when the minor premise is changed into its affirmative equivalent. Then we escape the fallacy of "two negatives."

(2) Only the Express train does not stop at this station.
The last train did not stop at this station.
∴ The last train must be the Express.

This is also a valid conclusion from two apparently negative premises. It can be obtained by a manipulation of the premises thus:—

The train that does not stop at this station is the Express

The last train is one that did not stop at this station.
∴ The last train is the Express.

In this case, the premises are both affirmative because the negative particle *inside the body* of a term does not make the whole proposition negative.

(3) None but the wise are good
None but the good are happy
∴ None but the wise are happy.

Here the conclusion seems to have been elicited *from two* negative premises, but an *exclusive proposition* when it is negative is really an affirmative proposition. In this way, all the three propositions in this syllogism can be stated thus:—

All good people are wise
All happy people are good
∴ All happy people are wise.

And in this form its validity is quite obvious. If the premises are really negative, after being turned into equivalent affirmatives, there will be a breach of Rule III or IV. *Rule V is a direct statement of this fact.*

Rule VI : If one of the premises is negative the conclusion is negative and vice versa, (that is, if the conclusion is negative, one of the premises must be negative.)

[Exclanation : Both the premises cannot be negative, but one can; but in that case, one premise disconnects one *extreme term from* the middle term, and the other premise connects the other extreme term with the middle: consequently, the two *extreme terms* will have to be *disconnected from* each other, that is, the conclusion will have to be negative. Similarly, a negative conclusion means that the two extreme terms are disconnected. They cannot both be disconnected from the middle *term*, for then there would be no conclusion at all (Rule V). Therefore, one premise must disconnect an extreme term from the middle term with which the other *premise must* connect the *other* term : *that is, one* of the premises must be negative.]

This Rule *may* also be stated in these ways:— (1) If both the premises are affirmative the conclusion (*where available*) *must be affirmative* (2) *If* the

conclusion is affirmative, both the premises must be affirmative.

Out of these six Rules, the first two are merely about the structure of the syllogism. The structural rules being observed, the *validity* of a syllogism is to be decided by the application of the next four Rules (Rules III, IV, V & VI). These four rules require no proof as they are ingrained in the Laws of Thought. But two more Rules follow from these Rules and are proved by means of them. So, these two, after being once shown to be corollaries from the preceding Rules, may be applied along with the rest to determine the validity of syllogistic reasoning.

Rule VII: From two particular premises nothing can be inferred.

[Proof: The premises must be either (*a*) both negative, (*b*) both affirmative, or (*c*) one affirmative and one negative.

(*a*) If they are both negative, nothing can be inferred from them [Rule V].

(*b*) If both are affirmative, no term is distributed in them, and as the middle term must be distributed at least once, there can be no inference.

(*c*) If one is affirmative and one negative, only one term will be distributed in the premises, namely, the predicate of the negative premise. But one premise being negative, the conclusion must be negative (Rule VI) and will distribute the major term. As only one term is distributed in the premises, if it is the middle term, then the major term being undistributed in the premise but distributed in the conclusion,

there will be an illicit process of the major term. If the distributed term is the major term, then the middle term is not distributed even once in the premises and therefore nothing can be inferted. So in no case can valid inference be drawn from two particular premises.]

This Rule may be proved, in a more practical manner, by taking the alternatives by their names thus:— (1) O O: (2) I I: (3) I O: O I. But the line of further proof is still the same as above.

Rule VIII: *If one of the premises is particular the conclusion must be particular.*

[Proof: Dismissing the alternative of two negative premises (as they yield no conclusion), the premises must be (*a*) both affirmative or (*b*) one affirmative and one negative.

(*a*) If they are both affirmative, (one particular and one universal), *only* one term *will be distributed* in the premises, namely, the subject of the universal *premise*. But that *will have to be the middle term*. So the minor term is undistributed in the premise and *must remain undistributed in the conclusion, that is*, the conclusion must be particular.

(*b*) If one premise is affirmative and one negative (at the same time, one particular and one universal), only two terms will be distributed in the premises, namely, the subject of the universal premise and the predicate of the negative premise. One of these must be the middle term, and the other must be the major term, because, one premise being negative, the conclusion will be negative and will distribute the major term. So the minor term is undistributed in the premise

and must remain undistributed in the conclusion; that is, the conclusion must be particular. So, in all possible cases of a particular premise, the conclusion must be particular..]

This Rule, too, like the preceding, may be proved, in a more practical manner, by taking the alternatives by their names thus:—

EO, OE (*to be dismissed as two negative premises*)

(*a*) AI, IA (both affirmative)

(*b*) AO, OA, EI, IE (one affirmative, one negative)

But here, too, the line of further proof is the same.

There is a similarity between Rule V and Rule VII and between Rule VI and Rule VIII. What the former, in each case, says about negative quality, the latter *says about particular quantity*. *But there is this difference* between Rule VI & Rule VIII viz. whereas Rule VI applies both ways, (that is, from premise to conclusion and from conclusion to premise), Rule VIII *applies only one way, from premise to conclusion*). The converse, viz. "If the conclusion is particular, one of the premises must be particular" is not correct. For there is no logical error if the premises are both universal and yet the conclusion is particular.

(4) Figures and Moods of the Syllogism

The *Dictum of the Syllogism* has been seen to yield directly *four* forms of the syllogism (P. 97), in all of which the middle term is the subject in the major premise and predicate in the minor premise; but the middle term can have other positions also. A form of the syllogism as determined by the positions of the middle term

in the two premises is called a *Figure* of the Syllogism. There are four different possibilities of these positions, namely,

(1) The middle term as subject in the major premise and *predicate* in the minor premise.

This form is called *Figure* I :— $\begin{array}{l} M - P \\ S - M \\ S - P \end{array}$

(2) The middle term as predicate in both the premises. This form is called *Figure* II :— $\begin{array}{l} P - M \\ S - M \\ S - P \end{array}$

(3) The middle term as subject in both the premises.

This form is called *Figure* III :— $\begin{array}{l} M - P \\ M - S \\ S - P \end{array}$

(4) The middle term as predicate in the major premise and subject in the minor premise.

This form is called *Figure* IV :— $\begin{array}{l} P - M \\ M - S \\ S - P \end{array}$

A form of the syllogism as determined by the *forms* of its three propositions is called a Mood of the syllogism. As there are four forms of the categorical proposition, (A, E, I, O), and three propositions at a time make up a syllogism, there will be 64 *mathematically* possible moods, as follows :—

(1) A A A	(17) E A A	(33) I A A	(49) O A A
(2) A A E	(18) E A E	(34) I A E	(50) O A E
(3) A A I	(19) E A I	(35) I A I	(51) O A I
(4) A A O	(20) E A O	(36) I A O	(52) O A O
(5) A E A	(21) E E A	(37) I E A	(53) O E A
(6) A E E	(22) E E E	(38) I E E	(54) O E E
(7) A E I	(23) E E I	(39) I E I	(55) O E I
(8) A E O	(24) E E O	(40) I E O	(56) O E O
(9) A I A	(25) E I A	(41) I I A	(57) O I A
(10) A I E	(26) E I E	(42) I I E	(58) O I E
(11) A I I	(27) E I I	(43) I I I	(59) O I I
(12) A I O	(28) E I O	(44) I I O	(60) O I O
(13) A O A	(29) E O A	(45) I O A	(61) O O A
(14) A O E	(30) E O E	(46) I O E	(62) O O E
(15) A O I	(31) E O I	(47) I O I	(63) O O I
(16) A O O	(32) E O O	(48) I O O	(64) O O O

Though these 64 moods are mathematically possible, they are not all *logically* possible or valid. The invalid moods can be weeded out, in the first instance, by the application of the General Rules. No mood which violates one or more of these Rules can be valid. The following moods are invalid for violating the Rules mentioned:—

(2) (4) (5) (7)—Rule VI; (9)—Rule VIII; (10) (12) (13)—Rule VI; (14)—Rule VIII; (15) (17) (19)—VI; (21) (22) (23) (24)—Rule V; (25)—VI;—(26)—VIII; (27)—VI; (29) (30) (31) (32)—V; (33)—VIII; (34)—VI and VIII; (36)—VI; (37)—VI; (38)—VIII; (39)—VI; (41) (42) (43) (44) (45) (46) (47) (48)—VII; (49)—VI, VIII (50)—VIII; (51)—VI; (53) (54) (55) (56)—V; (57) (58) (59) (60) (61) (62) (63) (64)—VII.

One more, namely, (40) I E O is invalid by special application of the Rules, thus:—The conclusion distributes the major term though it is undistributed in the major premise which is an I proposition (and distributes no term). Hence there will be an illicit process of the major term.

So only the following *Eleven* moods remain valid:—
(1) A A A: (3) A A I: (6) A E E; (8) A E O; (11) A I I: (16) A O O; (18) E A E; (20) E A O: (28) E I O; (35) I A I; (52) O A O.

This does not mean that all the eleven are valid in the four Figures; for to be valid they will have to stand the test of the application of the General Rules to the special conditions of the different Figures.

The valid moods in each Figure (out of these eleven) may be determined in one of two ways. Each mood may be put into the form of the different Figures and tested by the General Rules. For example, if A A A is put into Figure I, it will run thus:—All M is P
All S is M
∴ All S is P,

There is no violation of any one of the General Rules and therefore, this Mood is valid in Figure I.

If A E E is put into the form of Figure I, it will run thus:—All M is P
No S is M
∴ No S is P

But in this case, P is distributed in the conclusion though undistributed in the premise; therefore, the mood, A E E is not valid in Figure I. All the eleven moods may thus be tested in this and the other Figures. But

this would be a very laborious process. There is another, and a more intelligent way, of determining the valid moods, in each Figure, and that is by first framing *Rules for each Figure* as following out of its peculiar form, and then applying these Rules to the eleven moods. These Rules are called the "Special Rules" of the Figures.

(5) The Special Rules of the Figures

The following Rules can be laid down for the four Figures:—

FIGURE I

Rule 1 :— The major premise must be universal.

Rule 2 :—The minor premise must be affirmative.

These Rules may be proved in the following way:—

Structure of Fig. I
M — P
S — M
S — P

Rule 1 :—The major premise must be universal.

[Proof : Suppose the major premise is not universal, but particular ; then the middle term is not distributed in the major premise ; it must, therefore, be distributed in the minor premise ; therefore, the minor premise must be negative ; but then, the major premise will have to be affirmative, and the conclusion will be negative. The conclusion will then distribute the major term though undistributed in the premise ; in short, there will be an illicit process of the major term, if the major premise is particular. The major premise must, therefore, be universal.]

Rule 2:— The minor premise must be affirmative.

[Proof: Suppose it is not affirmative, but negative. Then, the major premise must be affirmative, and the conclusion must be negative. The conclusion will distribute the major term, though it is undistributed in the major premise. Hence, if the minor premise is negative, there will be an illicit process of the major term. It must, therefore, be affirmative.]

FIGURE II

Rule 1 :—The major premise must be universal.

Rule 2 :—One of the premises (and therefore, the conclusion) must be negative.

These Rules may be proved in the following way:—

Structure of Fig II — P — M
S — M
S — P

Rule 1:—The *Major* premise must be universal.

[Proof: Suppose it is not universal, but particular; then the major term will be undistributed in the premise and therefore must remain undistributed in the conclusion; the conclusion will then be affirmative, therefore, both the premises must be affimative, but then the middle term will not be distributed at all. Hence, if the major premise is particular, there will be a fallacy of "*undistributed middle*". *It must, therefore, be* universal.]

Rule 2:—*One of the premises (and therefore, the* conclusion) must be negative.

[Proof: *Suppose* both premises are affirmative, then the middle term will not be distributed in any premise. *Hence, if one of the premises is not negative, there*

will be a fallacy of "undistributed middle." One of the premises must, therefore, be negative. Consequently, the conclusion will be negative (Rule VI)]

FIGURE III

Rule 1 :—The minor premise must be affirmative.

Rule 2 :—The conclusion must be particular.

These rules may be proved in the following way :—

$$\text{Structure of Figure III} - \begin{array}{c} M - P \\ M - S \\ S - P \end{array}$$

Rule 1 :—The minor premise must be affirmative.

[Proof : Suppose it is not affirmative but negative ; then the major premise must be affirmative ; and the conclusion must be negative. The conclusion will then distribute the major term though it is undistributed in the premise. Hence, if the minor premise is negative, there will be an "illicit process of the major term." It must, therefore, be affirmative.]

Rule 2 :—The conclusion must be particular.

[Proof :—As the minor premise must be affirmative (according to Rule 1), the minor term will be undistributed in the premise and must remain undistributed in the conclusion ; that is, the conclusion must be particular.]

FIGURE IV

$$\text{Structure of Figure IV} - \begin{array}{c} P - M \\ M - S \\ S - P \end{array}$$

Rule 1 :—If the major premise is affirmative, the minor premise must be universal.

[Otherwise, the middle term will not be distributed at all.]

Rule 2 :— If the minor premise is affirmative, the conclusion must be particular.

[Otherwise, there will be an illicit process of the minor term.]

Rule 3 :—If one of the premises (and consequently, the conclusion) is negative, the major premise must be universal.

[Otherwise, there will be an illicit process of the major term.]

(6) Valid Moods in the Four Figures

Applying these rules to the eleven moods, (See P. 120) we get the following valid Moods :—

FIGURE I

(1) A A A : (2) A A I ; (3) A I I ; (4) E A E ; (5) E AO and (6) E I O.

But out of these, (2) A A I ; and (5) E A O have the same premises as the preceding ones, viz. (1) A A A and (4) E A E, respectively, but only subaltern conclusions of those of the preceding. Moods wherein a particular conclusion is stated even though its subalternant is legitimate are called *Subaltern Moods* or *Weakened Syllogisms.* The conclusion is unnecessarily weakened in these moods. Such moods are secondary ones. So, in Figure I, there are only *four* principal Moods namely, A A A ; A I I ; E A E ; and E I O.

FIGURE II

(1) A E E (2) A E O (3) A O O (4) E A E (5) E A O

and (6) E I O : But here again, (2) A E O and (5) E A O are subaltern moods of the preceding. So, there are *four* principal moods in Figure II, namely,

A E E; A O O; E A E and E I O.

FIGURE III

(1) A A I (2) A I I (3) E A O (4) E I O (5) I A I and (6) O A O.

It will be observed that there are two moods here, viz:, (1) A A I and (3) E A O, which give the same conclusion as is given by the following moods, namely, (2) A I I and (4) E I O, respectively, by means of premises one of which is subalternant of the premise in the corresponding mood. Moods wherein a premise is subalternant even though the subalternate would have yielded the same conclusion are called *Strengthened* Syllogisms, or *Strengthened* Moods. The premises are here unnecessarily strengthened. The difference between a weakened syllogism and a strengthened syllogism is this that in the former the *conclusion* is weakened, and in the latter, a *premise* is strengthened. The conclusion is, in both cases, particular. There can be no subaltern mood in Figure III as the conclusion is always particular. So all the six moods are primary moods.

FIGURE IV

(1) A A I (2) A E E (3) A E O (4) E A O (5) E I O (6) I A I. But of these, (3) A E O is a weakened mood of (2) A E E and, therefore, not to be included among the primary moods which are five, namely, A A I; A E E; E A O; E I O and I A I.

Thus there are altogether *nineteen* primary valid

moods: four in Figure I, four in Fig. II, six in Fig. III, and five in Fig. IV. If the five subaltern moods are added, there will be six moods in each Figure.

As there is no strengthened mood in Fig. I and Fig. II. there is no wastage of the distribution of any term. For this reason the moods of Figures I and II have been called *fundamental moods*.

In order to facilitate the remembrance of the nineteen moods and also to facilitate the work of '*Reduction*' (to be explained in the sequel), verses have been framed, indicating the moods by the vowels in the words. These verses, which are called "*Mnemonic Lines*" run thus

Barbara, Celarent, Darii, Ferio(que prioris)
Cesare, Camestres, Festino, Baroco, (secundae)
(Tertia) *Darapti, Disamis, Datisi, Felapton,*
Bocardo, Ferison, (quarta insuper addit),
Bramantip, Camenes, Dimaris, Fesapo, Fresison.

(7) Characteristics of the Four Figures

FIGURE I

Aristotle looked upon the First Figure as the perfect Figure, and recognised the Second and Third Figures as imperfect. The Fourth Figure was not recognised by him at all. There are some very good reasons for the superiority of the First Figure over the rest.

(i) In the first place, it alone complies directly with the Dictum or principle of the syllogism. The moods of this Figure form the most natural ways of reasoning, as the subject of the conclusion is the subject in the

premise and the predicate of the conclusion is the predicate in the premise.

(ii) Secondly, as Aristotle himself pointed out, this is the Figure that is most necessary in the progress of scientific knowledge as it alone proves a universal, affirmative proposition. What science seeks is *universally* true judgments, giving some *positive* information.

Not only in science, but in the practical concerns of life also, it is the First Figure that is most resorted to. Whenever a general rule is applied to a particular case, it always takes the form of a syllogism in Barbara. As Professor Mellone has so succinctly pointed out, in Grammar, Ethics, Law, Economics, History, Medicine etc., it is the First Figure that is largely employed

(iii) Thirdly, it is in this Figure alone that all the four forms of propositions (namely, A, E, I, O) can be proved, so that argument with any conclusion can be framed in this Figure. It is this feature of Figure 1 that facilitates the process of *Reduction*.

(iv) Lastly, it is in this Figure that the terms have extension according to their names of major, middle and minor.

FIGURE II

This Figure, too, has its own special features. As the conclusion is always negative, arguments that aim at drawing distinctions between things best fit in in this Figure. For instance, if I want to hint that a particular person is not wise, all I need do is to say that wise persons behave in a particular way but he does not, or that wise persons do not behave in a particular way but he

does. These are, logically, the moods, A E E and E A E of Figure II.

Secondly, for want of positive information, we have to rest content, sometimes, with negative, and then this Figure is most handy.

FIGURE III

This Figure, it is true, never gives a *universal* conclusion which is the goal of science; but by proving a particular conclusion, it at least *suggests* the path of future inquiry. If a conjunction or disjunction is known to hold in some cases, the line of inquiry for universal law is thereby *suggested*. For this reason, Figure III has been called the *Inductive Figure*. Secondly, this Figure is immensely useful in *refuting* an adversary's conclusion which is generally of a sweeping, universal type. Thirdly, a special advantage of this Figure is to make valid conclusion possible *from a few* or even *one instance*. If Goethe was a man of scientific genius; and he was a poet, that, "Some poets are men of scientific genius" easily follows.

FIGURE IV

This Figure was not recognised by Aristotle. It was added later on by a commentator named Galenus and is sometimes called the Galenian Figure after him. So far as symmetry is concerned with regard to the *positions* of the middle term, this Figure must get recognition; but from the point of view of pure logic, it is *superfluous*, as by merely interchanging the premises we get the First Figure. It is also extremely *unnatural*, as the subject and predicate

of the conclusion do not hold these places in the premises. What is expected to be the subject is unnaturally turned into the predicate of the conclusion. Thus in the following argument (in Fig. IV)

All roses are plants
All plants require air,
∴ Some things requiring air are roses,

where something is expected to be predicated of roses, one is shocked to hear 'roses' being predicated of 'some things requiring air'!

(B) Reduction

(8) "Reduction"

Figure I, as has been seen, is the most natural expression of the principle of the syllogism, and on this account it was called the Perfect Figure by Aristotle. Moods of Figures II and III were recognised by him to be valid, because the same conclusion could be shown to follow from the same premises when they were changed into the form of the First Figure. This process of altering the expression of a reasoning in Figure II, III or IV, into its equivalent in Figure I, is called '*Reduction*.' Sometimes the word is applied to a change from one Figure to any other Figure; but it should be restricted to the change to the First Figure, as that is the most natural Figure. As the other Figures have their own Special Rules and characteristics, they need not depend on "*reduction*" for their validity. However, 'reduction' affords an excellent intellectual *exercise*, and also shows the *unity* of all valid reasoning. Reduction, according to Aristotle, could be effected by

the help of conversion applied to one or both of the premises or to the conclusion from the new premises and by transposition of the premises, if necessary. This mode of reduction is called *Ostensive* or *Direct* reduction. As conversion was the only mode of immediate inference recognised by Aristotle and as an O proposition cannot be converted, two moods, namely, AOO of Figure II and OAO of Figure III could not be reduced by the direct method. To meet the difficulty, Aristotle invented another method of reduction called *Reductio per impossibile* or "*Indirect reduction.*" In this process, a reasoning in Figure I is resorted to to show how if the original conclusion is contradicted, the contradictory, when combined with one of the original premises, yields a conclusion which contradicts the other original premise; and as this is impossible, the original conclusion could not be contradicted. Indirect reduction, though first introduced to be applied to A O O, and O A O, (of Figure II and III), can be applied to any other mood as well.

If however, processes other than conversion, like obversion, *contraposition, etc.* are admitted, even the moods, A O O, and O A O, can be reduced directly. But even direct reduction is unnecessary as any concrete syllogistic reasoning can be tested by the application of the Rules of the syllogism.

The "mnemonic lines" referred to on P. 116 are so drafted that in addition to mentioning the nineteen valid moods, they indicate the processes to be applied for purposes of '*reduction*,' thus:—

(i) The initial letter of the mood indicates that it is to be reduced to that mood of Figure I, which begins

with the same initial letter. For example, in *Camestres* (of Figure II) the 'c' shows that it is to be reduced to '*Celarent*' (of Figure I).

(ii) '*s*' *indicates that the proposition shown by the* preceding vowel is to be converted *simply*.

(iii) 'p' indicates that the proposition shown by the preceding vowel is to be converted *per limitation*.

(*iv*) 'm' indicates that the premises have to undergo *metathesis* or transposition,

(v) 'c' indicates that the mood is to be reduced by *contradiction*, that is, by the indirect method.

(vi) Letters other than these are unmeaning.

The following exercises will illustrate the working of these suggestions:—

(1) E A E of Figure II,
expressed in symbolic propositions, will read as

No P is M—E
All S is M—A
∴ No S is P—E

As it is named *Cesare*, the E proposition, as indicated by the following 's,' is to be converted simply. The Syllogism will then become

No M is P—E
All S is M—A

∴ No S is P—E, which, as the initial letter c indicates, is *Celarent* of Figure I.

(2) I A I, of Figure III, is named *Disamis*. Symbolically expressed, it will read

Some M is P—I
All M is S—A
∴ Some S is P—I

As indicated by 's.' the I proposition is to be converted, and as indicated by 'm,' the premises are to be transposed. The syllogism will then become

All M is S — A
Some P is M — I
∴ Some P is S — I

Which is *Darii* of Figure I; and the conclusion being converted, as indicated by the last 's', we get it as Some S is P.

(3) E A O, of Figure IV is named *Fesapo.* Symbolically expressed, it will be

No P is M — E
All M is S — A
∴ Some S is not P — O

According to the hints, the E premise is to be converted simply, and the A premise to be converted per limitation. The Syllogism will then become

No M is P — E
Some S is M — I
∴ Some S is not P — O

Which is, as the initial letter F indicates, *Ferio* of Figure I.

(4) A O O, of Figure II. This is named *Baroco.*

The 'c' indicates that it is to be reduced by the *indirect process,* which will be as follows:—Expressed symbolically, the syllogism reads as

All P is M — A (Prop. 1)
Some S is not M — O (Prop. 2)
∴ Some S is not P — O (Prop. 3)

Suppose Prop 3 is not true; then its contradictory, All S is P – (Prop. 4) must be true. Combining Prop. 4

as minor premise, with Prop. 1 as major premise, we get a mood in Figure I, as

All P is M — (Prop. 1)
All S is P — (Prop. 4)
∴ All S is M — (Prop. 5)

But as Prop. 5 contradicts Prop. 2 which is given true, Prop. 5 must be *false*; therefore, one of the premises that give Prop. 5 as conclusion, must be false. Out of these, Prop. 1 is given to be true: therefore, Prop. 4, which is the other premise, must be false; therefore, its contradictory, that is, the original conclusion (Prop 3) must be true

(5) Similarly, O A O of Figure III will be reduced *indirectly*, (as the 'c' in *Bocardo* indicates) thus :—

Some M is not P — O (Prop. 1)
All M is S — A (Prop. 2)
∴ Some S is not P — O (Prop. 3)

If the conclusion, Prop. 3, is not true, its contradictory, All S is P — (Prop. 4) must be true. Combining this as major premise with Prop. 2 as minor premise, we get a syllogism in Figure I, as

All S is P — (Prop. 4)
All M is S — (Prop. 2)
∴ All M is P — (Prop. 5)

But as Prop. 5 contradicts Prop. 1 which is given to be true, Prop. 5 must be false; therefore, one of the premises that give Prop. 5 as conclusion, must be false. It cannot be Prop 2 which is given to be true; therefore, Prop. 4, which is the other premise, must be false; therefore, its contradictory, that is, the original conclusion (Prop. 3) must be true.

The last mentioned two moods, namely, A O O (Fig. II,) and O A O (Fig. III), can be reduced *directly* if the process of obversion is admitted in addition to conversion. The names, *'Faksoko* and *Doksamosk*, wherein, 'k' means obversion, are given to these two moods to indicate the processes necessary for direct reduction.

(6), *To take up A O O of Fig. II, for direct reduction:*

All P is M—A
Some S is not M—O
∴ Some S is not P—O

As indicated by 'ks' the A premise is to be obverted and then converted, thus becoming; by obversion, "No P is not-M," and by conversion, 'No not-M is P; and the O premise, as indicated by 'k' is to be obverted, thus becoming "Some S is not-M." The syllogism will then become

No not-M is P—E
Some S is not-M—I
∴ Some S is not P—O

Which, as indicated by the initial *F*, is *Ferio* of Fig. I.

(7) Similarly, O A O of Fig. III can be *directly* reduced in the following manner:—

Some M is not P—O
All M is S—A
∴ Some S is not P—O

As the letters 'ks' indicate, the O premise is to be obverted and then converted, thus becoming, by obversion, 'Some M is not-P' and then, by conversion, "Some not-P is M." As indicated by 'm' the premises are to be transposed, thus giving a syllogism in *Darii* of Fig. I, as

All M is S—A
Some not-P is M—I
∴ Some not P is S—I

and, as indicated by 'sk' at the end of the name, by converting and then obverting the conclusion, we get the original conclusion 'Some S is not P.'

(8) Any mood other than A O O and O A O can also be 'reduced' indirectly, by showing how, if the original conclusion is contradicted, the contradictory, combined with one of the premises in a First Figure syllogism, gives a conclusion which is incompatible with the remaining premise. For illustration, A E E of Figure II may be reduced indirectly thus:—

The original syllogism stands as

All P is M— (Prop. 1)
No S is M— (Prop. 2)
∴ No S is P— (Prop. 3)

If the conclusion, Prop. 3, is false, its contradictory, Some S is P (Prop. 4) must be true. Combining it, as minor premise, with Prop. 1 as major premise, we get, in Figure I,

All P is M—A (Prop 1)
Some S is P—I (Prop 2)
∴ Some S is M—I—(Prop 3).

a conclusion which contradicts the remaining premise (Prop. 2); but as this is impossible, the original conclusion, Prop 3, cannot be contradicted, that is, it must be true.

Though the work of 'reduction' is greatly facilitated by the help given by the 'mnemonic lines,' an intelligent

grasp of the structure of the different *Figures* is sufficient to enable one to work out the reductions. At any rate the mnemonic verses make the process quite mechanical. No reference should, therefore, be made to them in any reduction that claims to be *intelligently* worked out.

(C) Abridged Syllogisms

(9) Enthymeme

Though a fully expressed syllogism, as has been seen, consists of three propositions, in ordinary speech or writing all the three propositions are not explicitly stated, but one or more are implicitly understood. Indeed, so often is this the case that as one writer has put it, a completely expressed syllogism is hardly to be met with except in a Logic text-book. *Enthymeme* is the name given to an *incompletely expressed syllogism. The word is* taken from Aristotle who defined enthymeme as an "incomplete syllogism." By 'incomplete', however, Aristotle meant one with an uncertain or *probable* conclusion. For instance, if one were to argue that because fever-stricken patients are thirsty, and a particular patient is thirsty, therefore, the particular patient is fever-stricken, such an argument would have been called an enthymeme by Aristotle, as it gives only a probable conclusion and not one which follows with certainty from the premises. However, at present, the word, 'Enthymeme,' is applied to an incomplete syllogism in the sense of 'an *incompletely expressed* syllogism.' It is not a different kind of reasoning at all. The same tests, therefore, are to be applied to it as to the Syllogism, after expressing the 'suppressed' proposition or propositions.

An Enthymeme is said to be of the First Order, or Second Order, or Third Order, according as the major premise, or minor premise or the conclusion is unexpressed.

Symbolically, the three orders may be expressed thus :—

First Order : A is B, because it is C.
Second Order : A is B, because all C is so.
Third Order : C is B, and A is C.

More concretely, the syllogism,

All men are mortal;
Socrates is a man.
∴ Socrates is mortal.

may be enthymematically expressed in the three Orders, in the following ways :—

First Order : Socrates is mortal, because he is a man.
Second Order : Socrates is mortal, because all men are so.
Third Order : All men are mortal ; and Socrates is after all a man.

Sometimes, even one proposition implies a whole syllogism and is then called an enthymeme of the Fourth order, by some logicians ; for example, "He is too busy to come." which amounts to the syllogism, "People who are extremely busy cannot come. he is so ; therefore, he cannot come."

As an enthymeme is nothing else than a syllogistic reasoning, it should be put into the form of a completely expressed syllogism before being tested. The missing premise, (to be supplied,) should *as far as possible*, be such as would make the reasoning valid ; but between two propositions of equal validity, the *materially true* proposition should be preferred. Every

enthymeme need not, therefore, be a valid reasoni
The following examples will serve as illustrations :—

(1) Socrates was self-restrained, for all wise m
are so.

The conclusion is, "Socrates was self restrained ;
and as the expressed premise contains the term 'se
restrained,' it is the major premise ; so, the min
premise is 'suppressed,' that is, the argument is a
enthymeme of the Second Order. The minor premis
to be supplied, must connect the terms 'Socrates' an
'wise men.' To make the conclusion valid (withou
stating any obvious falsehood), the minor premise shoul
read as "Socrates was a wise man". The syllogism
will thus be

All wise men are self-restrained —A
(Socrates was a wise man) —A
∴ Socrates was self-restrained —A

in Figure I.

(2) "He must be a Buddhist, for all Buddhists hold these opinions."

The conclusion is, "He must be a Buddhist."

The major premise is given as "All Buddhists hold these opinions ;" the minor premise is to be expressed, but obviously it is, "He holds these opinions."

The whole syllogism will thus become

All Buddhists hold these opinions —A
(He holds these opinions) —A
∴ He is a Buddhist —A

The reasoning, in this case, is invalid, as the middle term, 'holding these opinions' is undistributed in both premises.

(D) Compound Syllogisms

(10) Poly-Syllogism

Just in the same way as two or more propositions may be combined for the sake of brevity into one sentence, two or more syllogisms may be combined into a chain of reasoning, by omitting some of the premises or conclusions. Such a chain of reasoning, comprising more than one syllogism in an abridged manner, is called a *Poly-syllogism*. The syllogism, whose conclusion is used as a premise for another syllogism, is called *a Pro-syllogism* and the latter an *Epi-syllogism*. If in the expression of the poly-syllogism, the pro-syllogism stands first, the reasoning is said to be *Progressive* and if the epi-syllogism stands first in the expression, the reasoning is said to be *regressive*.

(11) Epicheirema

The term '*Epicheirema*', is applied to a *regressive* poly-syllogism, that is, to a poly-syllogism in which, when it is fully expressed, the given syllogism stands as an epi-syllogism to the syllogism that is implied in one or both of the premises. More briefly, "an '*Epicheirema*' is a syllogism to one or both premises of which a reason is attached." According as a reason is attached to one or both premises, an Epicheirema is said to be 'Single' or 'of First Variety,' or 'Double' or of 'Second Variety.'

An Epicheirema of the First Variety may be symbolically expressed thus:—

All A is B, (because it is C)
All D is A
∴ All D is B

When fully expressed, it gives the two syllogisms :—

No. 1	No. 2
All C is B	All A is B
All A is C	All D is A
∴ All A is B	∴ All D is B.

It should be noted that Syllogism No. 2 which is the expressed syllogism, stands as an epi-syllogism to syllogism No. 1 which is *implied* in the major premise.

A Double Epicheirema may be expressed thus :—

All A is B, (*because it is* C)
All D is A (because it is E)
∴ All *D is* B

When fully expressed, it gives the following three syllogisms.

No. 1	No. 2	No. 3,
All C is B	All E is A	All A is B
All A is C	All D is E	All D is A
∴ All A is B	∴ All D is A	∴ All D is B.

It should be noted that Syllogism No. 3, which is the expressed one, uses as its premises the conclusions of the two implied syllogisms.

Thus an Epicheirema of the First Variety contains two syllogisms, and one of the Second Variety contains three syllogisms.

The relation between an enthymeme [1] and an *epi*cheirema will now be easily understood. An enthymeme is *only one* syllogism abridged, (that is, only a part of a syllogism is suppressed) whereas an epicheirema is a poly-syllogism abridged (that is, one or two whole syllogisms are suppressed). However, one or both premises of an epicheirema are enthymemes.

(12) Sorites

A poly-syllogism, when it is expressed in an 'abbreviated form in which is stated only one premise of each syllogism after the first and only the final conclusion of the whole argument, is called a *Sorites*. Sorites is thus a progressive chain of reasoning. There are, again, two types of Sorites. When the predicate of each proposition becomes the subject of the next, and in the conclusion the last predicate is applied to the first subject, it is called *Aristotelian* Sorites. When the subject of each proposition becomes the predicate of the next and in the conclusion the first predicate is applied to the last subject, it is called, *Goclenian* (after its inventor Goclenus) Sorites.

The following are symbolic illustrations of the two types :—

ARISTOTELIAN	GOCLENIAN
A is B	D is E
B is C	C is D
C is D	B is C
D is E	A is B
∴ A is E	∴ A is E

The two types are also called '*Progressive*' and '*Regressive*' Sorites ; but these words should be avoided, as even the so called '*Regressive*' sorites is a *Progressive* chain of reasoning. The expressed premises are the same in both types, but only the order is different.

Each Sorites, it will be seen, may be expanded into as many syllogisms as there are premises intervening between the first premise and the conclusion. Generally, it is the First Figure that is used for the Sorites though it is possible to use the others.

The following rules have been framed for the two types of Sorites (from the point of view of the use of Figure I in their expansion).

RULES OF ARISTOTELIAN SORITES:

(1) Only the first premise can be particular.

As each premise after the first has to become the major premise in its syllogism, it must be universal, (as required in the First Figure).

(2) Only the last premise can be negative.

As each premise before the last, (or a conclusion therefrom) has to become the minor premise in its syllogism, it must be affirmative (as required in the First Figure).

RULES OF GOCLENIAN SORITES

(1) Only the first premise can be negative.

Because every premise after the first has to stand as minor premise (in Fig. I), and must, therefore, be affirmative.

(2) Only the last premise can be particular.

Because every other premise (or a conclusion therefrom) has to stand as major premise (in Fig. I) and must, therefore, be universal.

In brief, in both the types of Sorites all the premises between the first and the last must be universal affirmative.

It will be seen that an Epicheirema can be expressed in the form of Sorites by stating the premises one after another in due order.

The Sorites is *frequently* used with hypothetical

propositions, in this way:—If A, then B; If B, then C; If C, then D: ∴ If A, then D, etc.

(13) Practice in Syllogistic Reasonings

Practical Exercises on the Syllogism form a very important branch of study. These may be of three types.:—

(A) *General Exercises*, that is, those which require the application of only the General Rules.

(B) *Special Exercises*, that is, those which require the application of the General Rules to *special* conditions of the different Figures and Moods.

(C) *Concrete Examples*, which require the application of the Rules to the given reasonings.

A few such exercises (with solutions, or hints for solution,) are given below :—

(A) General Syllogistic Exercises

Prove that

1. When the major term is predicate in its premise, the minor premise must be affirmative.

[Proof: The major term is either (*a*) distributed or (*b*) undistributed.

(*a*) If it is distributed, the major premise, with the major term as predicate, must be negative; therefore, the minor premise must be affirmative to avoid the fallacy of "two negatives."

(*b*) If it is undistributed, it must remain undistributed in the conclusion, which must, therefore, be affiirmative. Both the premises must, therefore, be affirmative; that is, the minor premise is affirmative.

So, in all cases, the minor premise must be affirmative, when the major term is predicate in its premise.]

2. When the minor term is predicate in its premise, the conclusion cannot be A.

[Proof: The minor term is either (*a*) distributed or (*b*) undistributed.

(*a*) If it is distributed, the minor premise, with the minor term as predicate, must be negative, therefore, the conclusion will be negative.

(*b*) If it is undistributed, it must remain undistributed in the conclusion; that is, the conclusion must be particular.

So, in no case can the conclusion be A, when the minor term is predicate in its premise.]

3. A particular major and a negative minor premise prove nothing.

[This has been proved incidentally, in determining the valid moods out of the 64 mathematically possible combinations (P. 110). A complete proof is here given:—

As the minor premise is negative, the major premise must be affirmative (Rule V); and as the major premise is particular, the minor premise must be universal (Rule VII), that is, the premises must be *I, E*. One of the premises being negative the conclusion will be negative (Rule VI) and the major term will be distributed in it; but the major premise, being I, does not distribute any term. Thus there is bound to be an illicit process of the major term. *Hence, no conclusion can be validly drawn* from a particular major, and a negative minor, premise.]

[The same exercise may be given in these forms :— .

(i) In a valid syllogism, if the minor premise is negative the major premise must be universal. (ii) The major premise of a syllogism, whose conclusion is negative, can never be particular affirmative.]

4. In no case can the contradictory of the conclusion follow from the contradictories of the premises.

[Proof: The conclusion is either affirmative or negative. If it is affirmative, both the premises must be affirmative; their contradictories will be both negative and will therefore yield no conclusion. If the conclusion is negative, one of the premises must be negative and one affirmative; their contradictories will be one affirmative and one negative, and will yield a negative conclusion; but if it is to be the contradictory of the original negative conclusion it will have to be affirmative. So, in neither case does the contradictory of the conclusion follow from the contradictories of the premises.]

5. In no case can one of the premises and the conclusion prove the other premise.

[Proof: In the first place, the conclusion must be combined with an affirmative premise; for if it is combined with a negative premise, it will yield no conclusion, as in that case it is itself negative. Now, if the affirmative premise, with which the conclusion is combined, is the major premise, either the major term (P) or the middle term (M) is undistributed in it (as an affirmative proposition does not distribute its predicate.) If the undistributed term is the major term, it must be undistributed in the conclusion; but now as the major term becomes the middle term, it will lead to an "undistributed middle," that is, no conclusion can be obtained. If the undistributed term is the middle (M) term, that

term must have been distributed in the minor premise, (to avoid 'undistributed middle.') But now if the minor premise (with the middle term, M, distributed) were to be the conclusion, there will be an illicit process of that term (M).

Similarly, if the affirmative premise, with which the conclusion is combined, is the minor premise, either the minor term (S) or the *middle term* (M) *is undistributed* in it; if it is the minor term, it must be undistributed in the conclusion; but as it now becomes the middle term, there will be an 'undistributed middle'; if it is the middle term, it must be distributed in the other premise (viz. the major premise); but now, if the major premise (with the middle term, M, distributed) were to be the conclusion there will be an *illicit process* of that term (M).

Thus, in a combination of the conclusion with one of the premises, either there is a fallacy of 'undistributed middle,' or "an illicit process of the original middle term," if the remaining premise were to be the conclusion. So the remainiog premise can never be the conclusion from the original conclusion and one of the premises.]

6. If the middle term is twice distributed, the conclusion must be particular.

[Proof: The premises must be either (*a*) both affirmative or (*b*) one affirmative and one negative.

(*a*) If both are affirmative, at the most there are two places for distribution, and as both are occupied by the middle term (according to the data), the minor term must be undistributed in the premise, and therefore, in

the conclusion, that is, the conclusion must be particular. (*b*) If one premise is affirmative and one negative, at the most there are three places for distribution. Out of these, two are occupied by the middle term (according to the data) and the third must be taken up by the major term, as one of the premises being negative the conclusion will be negative and will distribute the major term. So, the minor term must be undistributed in the premise, and therefore, in the conclusion; that is, the conclusion must be particular.]

[The same exercise may be given in this form:—

"If the conclusion of a valid syllogism is universal, the middle term is distributed only once."]

7. If the major term is distributed in the premise, but undistributed in the conclusion, the conclusion must be particular.

[Proof: As the major term is undistributed in the conclusion, the conclusion must be affirmative; therefore, both the premises must be affirmative. As the major term is distributed in the premise, and the middle term must be distributed at least once, there is no room, in the affirmative premises, for distribution of the minor term. The minor term, therefore, being undistributed in the premise, must be undistributed in the conclusion, that is, the conclusion must be particular.]

8. If the conclusions of two valid syllogisms having a common premise are combined as premises in a new syllogism, the conclusion must be particular.

[Proof: If the common premise is the major premise, the original major term will become the new middle term; it must, therefore, be distributed in one of the conclu-

sions (but not in both, as then both will be negative and will not make a valid syllogism), and in both the major premises, which are common. So, in one of the syllogisms, the major term, though distributed in the premise, is undistributed in the conclusion. This conclusion must be particular (as proved in the last exercise). As this particular conclusion becomes a premise in the new syllogism, the conclusion of the new syllogism must be particular.

If the common premise is the minor premise, the minor term will become the new middle term. It must, therefore, be distributed at least in one of the conclusions and in both the minor premises which are common. If it is distributed only in one conclusion, and not in the other, the other conclusion being particular will give a particular conclusion in the new syllogism; even if it is distributed in both the conclusions, as it will be the middle term twice distributed in the new syllogism, the conclusion of the new syllogism, (as proved in the last but one exercise) will be particular. So in all cases where conclusions of two valid syllogisms having a common premise are combined as premises, the conclusion must be particular.]

9. If two valid syllogisms have a common premise, while the other premises are contradictories, both the conclusions must be particular.

[Proof: In the first place, as the common premise is to combine once with a particular premise and once with a negative premise, it must itself be universal affirmative (A).

Secondly, if the middle term is distributed in one of the contradictory premises, it cannot be distributed in

the other; so in one case at least the middle term has to be distributed in the common premise: but the premise is common, and so the middle term is distributed in the common premise in both the syllogisms.

Thirdly, the common premise, which is to be A and to distribute the middle term, cannot be the major premise, because in that case, the major term though distributed in the conclusion (as, one of the contradictory premises being negative, the conclusion will be negative) will be undistributad in the premise; thus, the common premise must be the minor premise, and as it must be A and must distribute the middle term, the minor term is undistributed in it, and therefore, in the conclusion; that is, the conclusion must be particular.]

(B) Special Syllogistic Exercises

Determine the Mood and Figure, if in a valid Syllogism:—

(1) The conclusion is universal affirmative (A).

[The conclusion is affirmative; therefore, both the premises must be affirmative; the conclusion is universal; therefore, both the premises must be universal; that is, the premises are both universal affirmative, (A' s). Hence the mood is A A A.

As the minor term is distributed in the conclusion it must be distributed in the minor premise and must be the subject therein. The middle term must be distributed in the major premise and must be the subject therein.

Thus, the middle term is subject in the major premise and predicate in the minor premise; that is, the Figure is *First*.

Thus the Mood is A A A in *Fig. I*]

(2) The minor premise is particular negative (O).

[*As one premise, the minor, is particular and negative*, the conclusion must be particular and negative (O): and the *other premise, the major*, must be *universal* affirmative. Therefore, the mood is A O O.

As the major term is distributed in the conclusion, it must be distributed in the major premise A, where it must, therefore, stand as the subject. The middle term, in order to be distributed, must stand as the predicate in the minor premise O. As the middle term is predicate in both the premises, the Figure is *Second*.

Thus the Mood is A O O in Fig. II]

(3) The major term loses quantity in the conclusion.

[As the major term is undistributed in the conclusion, the conclusion must be *affirmative*. Therefore, both the premises must be affirmative. They must both be A in order that the major term and the middle term should be distributed. The middle term must, therefore, stand as the predicate in the major premise and subject in the minor premise; that is, the Figure is *Fourth*. As the minor term is undistributed in the premise it must be undistributed in the conclusion which must, therefore, be particular (affirmative).

Thus the mood is *A A I* in *Fig IV*.]

(4) The major premise and conclusion agree in quantity but differ in quality.

[As the major premise and conclusion differ in quality the major premise must be affirmative and the conclusion negative (because it cannot be otherwise). The minor premise must be negative. As the major premise and conclusion agree in quantity, and the major premise

is affirmative, it must be universal (because a particular major, and a negative minor, premise, yield no conclusion (Vide General Exercise No. 3 above); that is, the major premise must be universal affirmative (A), and the conclusion universal negative (E). The minor premise must be universal negative (to yield a universal negative conclusion.) The mood is, thus, *A E E*. In the major premise (A), the major term must be the subject, and middle term, the predicate—All P is M. In the minor premise (E), the middle term may be either the predicate or subject—No S is M, or No M is S; therefore, the Figure must be either *Second* or *Fourth*.

Thus the mood is A E E in *Figure II*
or *A E E* in *Figure IV*]

(5) The major premise and conclusion differ in both quantity and quality.

[As the major premise and conclusion differ in both quantity and quality, they must be universal affirmative (A), and particular negative (O), respectively, (because it cannot be otherwise.) The minor premise must be E or O. The mood must, therefore, be *A E O* or *A O O*. In the major premise, the major term must be the subject (in order to be distributed). In the minor premise, if it is E, the middle term may be either subject or predicate; and if it is O the middle term must be the predicate (in order to be distributed). Thus the Mood is *A E O* in *Fig. II* or *IV* or *A O O* in *Fig. II*.]

(6) The middle term is distributed only in one premise and the other premise is negative.

[The premise, in which the middle term is distributed must be affirmative as the other premise is negative. therefore, it must be *A*. The negative premise must be

O, as the middle term is not to be distributed in it; and it must be major premise in order to distribute the major term which, (one of the premises and therefore the conclusion being negative), is distributed in the conclusion. The conclusion must be O. Thus the mood is O A O. In the major premise as well as in the minor premise the middle term is the subject. Therefore, it is *Figure* III. Thus the mood is O A O, in *Fig. III.*]

(7) If the middle term is twice distributed and the conclusion is negative.

[As already proved, (*in General Exercise No 6,*) the conclusion must be particular. Thus the conclusion is O. In order to distribute the middle term and the major, the major premise must be E; and in order to distribute again the middle term, the minor premise must be A. The Mood is, therefore, *E A O.* The major premise may be either, "No M is P" or "No P is M"; the minor premise is "All M is P;" therefore, the Mood is E A O in Fig. III or *Fig. IV.*]

(8) Only one term is distributed and that twice.

[As only one term is distributed, it must be the middle term; the conclusion must be I, as *neither the major nor* the minor term is distributed in the premises. Both the premises must be affirmative and both universal (to distribute the middle term twice.) *The middle term must* be the subject in both premises. Hence the Mood is A A I in *Fig. III.*]

(9) Prove that a mood which is valid in Figures II and III, is valid in Figure I and io Figure IV.

[*Proof*: A mood that is valid at *once* in Figures II and III must satisfy the requirements of both. The

conclusion must be negative (as required by Fig II) and particular (as required by Fig. III), that is, O. The major premise must be universal (to be valid in Fig. II); and the minor premise must be affirmative (to be valid in Fig. III). Such a mood (which will be E A O or E I O) must be valid in Fig I, as the major premise is universal and minor premise is affirmative. It must also be valid in Fig. IV as it satisfies the relevant requirements of that Figure, (namely, the minor premise being affirmative, the conclusion is particular; and the conclusion being negative, the major premise is universal.)]

[Note that in this problem as stated above, the phrase, "Valid in Figures II and III" is to be interpreted in the *collective* sense.]

(C) Concrete Syllogistic Examples

Put into Syllogistic form, explain the nature, and examine the validity of the following reasonings :-

[Note : In solving concrete examples, it is the *conclusion* that should be determined first ; the major premise should be determined next and the minor last ; the three should then be put down in the traditional order and the reasoning tested.]

1. Anything that is opposed to industrial prosperity is an evil ; wars are certainly evils : therefore, wars are opposed to industrial prosperity.

In proper form, the reasoning will stand as

All things that are opposed to industrial prosperity
are evils — A

All wars are evils — A

∴ All wars are opposed to industrial prosperity—A.

The reasoning is *invalid*, as the middle term, *evils*, is not distributed in any premise. The fallacy of *undistributed middle* has been committed.

The Mood *is* A A A in *Fig. II*, which *is invalid*.

2. All men are rational beings: all rational beings are progressive beings: therefore, *all* progressive beings are men.

= All men are rational beings—A
All rational beings are progressive beings—A
All progressive beings are men—A

This reasoning is *invalid*, committing the fallacy of the *illicit process of the minor term*. The minor term, "progressive beings," though undistributed in the premise, is distributed in the conclusion. The mood is A A A in Fig. IV, which is invalid.

3. Every candid man acknowledges merit in a rival; every learned man does not do so: therefore, every learned man is not candid.

= All candid men acknowledge merit in a rival—A
Some learned men do not acknowledge merit in a rival—O

∴ Some learned men are not candid—O

The reasoning is valid (*A O O, Fig. II*), there being no fallacy of 'undistributed middle' or 'illicit major.'

4. *Every soldier serves his country.* Women are *not* soldiers: therefore, no women serve their country.

= All soldiers serve their country—A
No women are soldiers—E
∴ No women serve their country—E

The reasoning is *invalid* on account of an *illicit process of the major term*, 'serving their country.' Mood A E E cannot be valid in Fig. I.

5. His cowardice might have been inferred from his cruelty; for all cowards are cruel.

In proper form,

= All cowards are cruel—A
He is cruel—A
∴ He is a coward—A

The reasoning is *invalid*, on account of the fallacy of "*Undistributed Middle.*" Mood A A A cannot be valid in Fig. II.

6. No young man is wise; for only experience can give wisdom; and experience comes only with age.

In proper form,

= All wise men are experienced—A
No experienced men are young—E
∴ No young man is wise—E

The reasoning is valid, being A E E in Fig. IV.

7. He must know a great deal for he says so little.

This is an *Enthymeme* of the *First Order* as the major premise is omitted. We cannot supply "All who say little know a great deal" as the major premise, though it would make the reasoning valid, because that is, obviously, not what is implied. What is implied is "All who know a great deal say little."

The syllogism will, therefore, run as

(All who know a great deal say little)—A
He says little—A
∴ He knows a great deal—A

The reasoning is *invalid* on account of '*undistributed middle.*'

8. Every truth is worthy of being known; but not every truth is directly useful.

Two propositions have been stated with a common term. They must therefore be premises of which the conclusion is unexpressed. The reasoning is, therefore, an *Enthymeme* of the *Third Order*.

As the middle term is subject in both premises, the Figure must be *Third*. O, which is one of the premises must be then the major premise. In proper form, the reasoning will be :—

Some truths are not directly useful—O
All truths are worthy of being known—A
∴ (*Some things worthy of being* known are not directly useful)—O

It is valid. The *Mood is* OAO *in Fig. III*.

9. No man is infallible, for no man is omniscient; Aristotle was a man; therefore, Aristotle was not infallible.

Though apparently one syllogism, it is really equivalent to two syllogisms, as a reason is attached to one of the premises. It is thus an *Epicheirema* of the *First Variety*. The major premise lays down that, as only the omniscient are infallible and no man is omniscient, no man is infallible. It may be expressed in the following way :—

All infallible people are omniscient—A
No man is omniscient —E
∴ No man is infallible — E

in Fig. II

Combining this conclusion with the other premise, we get the other syllogism, (which has been explicitly stated), viz.

No man is infallible — E
Aristotle was a man — A
∴ Aristotle was not infallible — E

in Fig. I. The reasoning as a whole, therefore, is quite valid.

10. No idle person can be a successful writer of history; therefore, Hume, Macaulay, Hallam and Grote must have been industrious.

The reasoning is an *Enthymeme* of the *Second Order*. Taking 'industrious' and 'not-idle' as equivalent in meaning and supplying the necessary minor premise, we validly get the conclusion in this way:—

No idle person can be a successful writer of history-E
(Hume, Macaulay, Hallam and Grote were successful writers of history)—A
∴ Hume, Macaulay, Hallam and Grote must not have been idle, (that is, must have been industrious.) —E
E A E, in Fig. II.

11. Whatever tends to withdraw the mind from pursuits of a low nature deserves to be promoted. Classical learning does this since it gives a taste for intellectual enjoyments; therefore, it deserves to be promoted.

This is an epicheirema of the First variety, as a reason is attached to one of the premises. It can be expanded into the following two syllogisms:—

Syllogism No 1.

(Whatever gives a taste for intellectual enjoyments tends to withdraw the mind from pursuits of a low nature:)—A

Classical learning gives a taste for intellectual enjoyments—A

∴ Classical learning tends to withdraw the mind from pursuits of a low nature—A

Syllogism No. 2

Whatever tends to withdraw the mind from pursuits of a low nature deserves to be promoted—A

Classical learning tends to withdraw the mind from pursuits of a low nature—A

∴ Classical learning deserves to be promoted—A

12. An avaricious man is one who desires more than he possesses; a man who desires more than he possesses is discontented; a discontented man is unhappy; therefore, an avaricious man is unhappy.

This is an Aristotelian Sorites. It can be expanded into *two* syllogisms. The reasoning is *valid*, as none of the rules of Aristotelian sorites is violated.

13. Only members of the Society took part in the discussion. You must have done so, for you are a member. In proper form, =

All who took part in the discussion are members of the Society—A

You are a member of the Society—A

∴ You must have taken part in the discussion—A.

The reasoning is *invalid* on account of the fallacy of "undistributed middle" that is committed by mood A A A in Fig. II.

14. No fallacy is a legitimate argument; any legitimate argument may *fail to win assent*; *therefore*, no *fallacy fails* to win assent.

The propositions must be transposed.
In proper form, the reasoning will stand as

Some legitimate arguments fail to win assent—I
No fallacy is a legitimate argument—E
∴ No fallacy fails to win assent—E

The reasoning is *invalid* as it commits an illicit process of the major term, 'failing to win assent.' As already noticed, no valid conclusion can be drawn from I E premises

15. It is impossible to maintain that the virtuous alone are happy, and at the same time that selfishness is compatible with happiness, but incompatible with virtue.

"Compatible with" makes the proposition particular affirmative, and "incompatible with" makes the proposition universal negative. The intended conclusion is "Some happy persons are not virtuous."
In proper form, the reasoning will stand as

No virtuous person is selfish—E
Some happy persons are selfish—I
∴ Some happy persons are not virtuous—O

The reasoning is in mood E I O in Fig. II: this mood is valid in all Figures. The reasoning is thus quite correct.

16. Some leaders of industry are advocates of a high tariff; some advocates of a high tariff are members of Parliament: therefore, some members of Parliament are leaders of industry.

The reasoning, in spite of a show of correctness, is altogether *wrong* as the *middle term* is *undistributed*. Two particular premises can never give a valid conclusion.

17. No man is wholly admirable, but no man is a proper object of contempt ; hence some beings who are not wholly admirable are not proper objects of contempt.

This should not be dismissed off hand as comprising the fallacy of "*two negative premises.*"

When properly arranged, the reasoning will stand as.

No man is a proper object of contempt — E
All men are beings who are not wholly admirable—A
∴ Some beings who are not wholly admirable are not proper objects of contempt. — O
The reasoning is *quite valid*, being EAO in *Fig*. III.

Questions on Chapter VII

1 Explain the Principle of the Syllogism and state its different formulations.
2 Explain the Rule about at least one distribution of the middle term and the Rule about two negative premises.
3 Prove that (i) Two particular premises yield no conclusion (ii). If one of the premises is particular, the conclusion must be particular.
4 What is meant by a *Figure?* What are the characteristics of the different Figures?
5 How will you determine the nineteen valid Moods of the Syllogism?
6 Write notes on :—(i) *A Weakened Syllogism* (ii) A Strengthened Syllogism. (iii) Fundamental Moods (iv) "Ambiguous Middle"
7 What is '*Reduction*'? What value does '*Reduction*' possess?
8 Explain and illustrate "*Indirect* Reduction."
9 Write notes on :—
(1) Enthymeme (2) Epicheirema and (3) Sorites.

CHAPTER VIII

CONDITIONAL REASONINGS

(A) The Hypothetical Syllogism

(1) Valid Moods of the Hypothetical Syllogism

When a conditional proposition or propositions form part of a reasoning, it is called a "Conditional Reasoning." There are three main forms of Conditional Reasoning, viz. (1) the Hypothetical Syllogism; (2) the Disjunctive Syllogism; and (3) the Dilemma.

A *Hypothetical Syllogism* (or a "*Mixed Hypothetical Syllogism*") is a reasoning which has a hypothetical major premise, a categorical minor premise, and a categorical conclusion.

In a hypothetical proposition, the antecedent asserts a condition or ground and the consequent asserts the consequence. The same consequence may follow from a plurality of causes; for instance, death may be the consequence of poisoning, or drowning or tuberculosis, etc. At least, in ordinary speech or writing, by 'cause' is meant one or another of a number of *alternative* causes. Consequently, there will be *two* valid moods of the Hypothetical Syllogism, according as (1) the Antecedent (that is, the condition) is affirmed in the minor

premise and the consequent affirmed in the conclusion, or (2) the consequent denied in the minor premise and the antecedent denied in the conclusion. The former is called "*Modus ponens*" or "*Constructive*;" and the latter is called "*Modus tollens*" or "*Destructive.*" These moods may be expressed thus:—

Modus ponens	*Modus tollens*
If A is B, C is D.	If A is B, C is D.
A is B.	C is not D.
∴ C is D.	∴ A is not B.

If the hypothetical major premise is changed into categorical form, the following two moods (of course valid) are obtained:—

The *modus ponens* becomes

All cases of A being B are cases of C being D
This is a case of A being B
∴ This is a case of C being D,

which is *Barbara*, (Fig. I)

The *modus tollens* becomes

All cases of A being B are cases of C being D
This is not a case of C being D
This is not a case of A being B,

which is *Camestres*, (Fig. II.)

(2) Invalid Moods of the Hypothetical Syllogism

As the condition stated in the antecedent is only *one out of many alternative* causes, to deny the antecedent in the minor premise and the consequent in the conclusion would be to commit a fallacy. This fallacy is called "Denying the antecedent". For example, from "If A takes poison, A will die" and "A will never take

poison," we cannot infer that "A will not die," for he shall die by some other cause.

Similatly, to affirm the consequent in the minor premise and the antecedent in the conclusion would be to commit a fallacy. This fallacy is called "Affirming the consequent." For example, from "If A takes poison, A will die" and "A is dead," we cannot conclude that "A had taken poison;" for he might have died by some other cause.

If the major premises are expressed in categorical forms these fallacious moods will become :—

(1) All cases of taking poison are cases of death.
  A's is not a case of taking poison
 ∴ A's is not a case of death.

(A E E in Figure I, which commits the fallacy of "*Illicit Major*") and

(2) All cases of taking poison are cases of death.
  A's is a case of death.
 ∴ A took poison

(A A A in Figure II, which commits the fallacy of "*Undistributed Middle*")

Besides these '*formal*' requirements, the *material* truth of the propositions (especially the connection stated in the major premise) is of vital importance. For example, "If potatoes are cheap, the Sun is invisible: potatoes are cheap; therefore, the Sun is invisible" cannot be formally objected to; but the major premise is ridiculously false.

(3) Pure Hypothetical Syllogism

Hypothetical syllogisms of the above mentioned structure, that is, those having the minor premise and the

conclusion in the categorical form, are sometimes called "*Mixed* Hypothetical Syllogisms" (as there is a mixture of categorical propositions with a hypothetical proposition) *to distinguish them from* "*Pure Hypothetical* Syllogisms" in which all the three propositions are hypothetical, as in

If C is D, E is F
If A is B, C is D
∴ If A is B, E is F

However, so far as the reasoning is concerned, there is no essential difference between the Mixed hypothetical, and the Pure hypothetical, syllogism, as even in the latter the argument *turns* upon the condition stated in the major premise. The conclusion, in the *Pure* Hypothetical Syllogism, merely repeats the condition expressed in the minor premise.

(4) Practice in Hypothetical Syllogisms

[The following points should be noted :—

(i) Before a *Hypothetical* syllogism is tested, it is necessary to put it into *logical form*, that is, to put the hypothetical premise (in the order of antecedent and consequent) first, the minor premise next, and the con*clusion* last. "*A is B, if it is C*; it is not C, *therefore*, it is not B" should be written as

If A is C, A is B
A is not C
∴ A is not B

(ii) If the word 'only' has been applied to the antecedent, the antecedent should be rewritten in the form required by an 'exclusive proposition,' before the

argument is tested; for example, "Only if A is B, C is D; A is B, therefore, C is D" should be written as

If A is not B, C is not D
A is B
∴ C is D

(iii) The affirming or denying must be practised on the *given* proposition. For instance, if the original proposition is negative, to *affirm* it is merely to repeat it in the negative form. Similarly, to deny it is to give the *contradictory* of the given proposition.]

Examples

(1) A is B, if it is C; it is not C, therefore, it is not B
= If A is C, A is B
A is not C
∴ A is not B

The reasoning is *invalid*. The fallacy committed is that of "*denying the antecedent*."

(2) A is not B, unless it is C; as it is not C, it is not B
= If A is not C, A is not B
A is not C
∴ A is not B

The reasoning is *valid*. It is in the *Modus Ponens* or *Constructive Mood*.

(3) If A is not B, C is not D; but as A is B, it follows that C is D.
= If A is not B, C is not D
A is B
∴ C is D

Invalid. Fallacy of "*denying the antecedent.*"

(4) A is not B, if C is D; C then is not D, for A is B.
= If C is D, A is not B
A is B
∴ C is not D
Valid: *Modus Tollens* or the *Destructive Mood.*

(5) Only if an officer is cool-headed does he deserve the chief command, and as this officer has not been thought worthy of the appointment, we may conclude that he is not cool-headed.

= If an officer is not cool-headed, he does not deserve the chief command.
This officer does not deserve the chief command.
∴ This officer is not cool-headed.
Invalid: fallacy of "*affirming the consequent.*"

(6) If all philosophical theories were sound, some would be accepted by a majority of thinkers: but as none are accepted by a majority of thinkers, none are sound.

Invalid, because the denial of the antecedent in the conclusion is not correctly done. The antecedent (which is A) should have beeo denied by its contradictory—O, and not by the contrary, E, as is here done.

(7) Fallacies would only be excusable, if they were unavoidable; but they are avoidable, therefore, they are inexcusable.
= If fallacies are not unavoidable, they are inexcusable
They are avoidable
∴ They are inexcusable
Valid: The minor premise is equivalent to the antecedent, that is, affirms the antecedent, and the conclusion affirms the consequent.

(8) No man should be punished, if he is innocent: this man should not be punished; therefore, he is innocent.

= *If a man is innocent, he should not be punished;*
This man should not be punished,
∴ This man is innocent.

Invalid: Fallacy of "*affirming the consequent.*"

(9) Unless a man is sincere, he is not trustworthy; therefore this man as he is sincere is trustworthy.

= If a man is not sincere, he is not trustworthy;
This man is sincere,
∴ *This man is trustworthy.*

Invalid: Fallacy of "*denying the antecedent.*"

(B) The Disjunctive Syllogism

(5) Valid Moods of the Disjunctive Syllogism

A *Disjunctive Syllogism* (or a Mixed Disjunctive Syllogism) is a reasoning wherein the major premise is a disjunctive proposition, the minor premise is a categorical proposition which affirms or denies one member of the disjunction, and the conclusion is a categorical proposition which denies or affirms the other member of the disjunction.

The disjunction must be the pivot on which the argument turns by means of the minor premise. A disjunctive major premise does not necessarily make a disjunctive Syllogism. The following arguments with disjunctive major premises are not disjunctive syllogisms :—

(1) A is either B or C
D is A
∴ D is either B or C

[This is really a categorical syllogism.]

(2) If A is B, either C is D or E is F
A is B
∴ Either C is D or E is F

[This is a hypothetical syllogism, and not a disjunctive one because the argument turns on the antecedent, and not on the disjunction stated in the major premise.]

The question of the valid moods of the disjunctive syllogism will have to be decided by reference to the import *of a disjunctive proposition, that is, by reference* to the question whether the disjunction is partial or complete. Mill and Jevons take it as partial. On their view, there will be only *one* valid mood (with its two forms) of the disjunctive syllogism; viz. where the minor premise *denies* one of the alternatives and the conclusion *affirms* the other.

This mood is called *Modus tollendo ponens* (or Affirming by denial.)

For example,

Either A is B or C is D
A is not B
∴ C is D

or

Either A is B or C is D
C is not D
∴ A is B.

But unless the disjunction is complete, that is, exhausts all the possibilites, the disjunctive proposition is no advance on the hypothetical. If the disjunction is complete, there will be one more mood, (with its two forms), viz. where the minor premise *affirms* one of the alternatives and the conclusion *denies* the other. This

mood is called "*Modus ponendo tollens*" (or Denying by Affirmation).

For example,

Either A is B or C is D
A is B
∴ C is not D

or

Either A is B or C is D
C is D
∴ A is not B

A sure method of judging the validity of a disjunctive syllogism consists in expressing the disjunctive major premise in the form of hypothetical propositions and then applying the Rules of the Hypothetical Syllogism to it. On the theory that the disjunction is complete, a disjunctive proposition amounts to two Hypothetical propositions.

"Either A is B, or C is D" means

(1) If A is B, C is not D; and
(2) If A is not B, C is D

From these follow

(3) If C is D, A is not B [Modus Tollens of (1)] and
(4) If C is not D, A is B [,, ,, (2)].

(6) Pure Disjunctive Syllogisms

As distinguished from the above *Mixed Disjunctive Syllogisms*, those which have *all* the propositions in the disjunctive form are called *Pure Disjunctive Syllogisms*. For example,

Either A is B or C is D
Either A is B or E is F
∴ Either E is F or C is not D.

It should be noted that the conclusion, if stated as "Either E is F or *C is D*" would be wrong. Out of the extreme alternatives, one must be affirmed and the other denied, in the conclusion. As the argument turns, in both types, upon the *disjunction* in the major premise, there is no fundamental *logical difference* between the *Mixed* and the *Pure*, Disjunctive Syllogism.

(7) Disjunctive Syllogisms with More Alternatives than two

If there are more alternatives than two, stated in the major premise, and the minor premise affirms one, the conclusion must *conjunctively deny* all the others.

For example,

Either A is B, or C is D, or E is F
A is B
∴ C is not D *and* E is not F.

The conclusion must be as stated here, because to deny is to state the contradictory, and the contradictory of the disjunctive proposition "Either C is D or E is F" is, as noticed in the "Opposition of Conditional propositions" (P. 79), "*C is not D and E is not F*" and not "Either C is not D or E is not F."

Similarly, if there are more alternatives than two, stated in the major premise, and the minor premise denies one, the conclusion must *disjunctively affirm* all the others.

For example,

Either A is B or C is D or E is F
A is not B
∴ Either C is D or E is F

It is easy to know why the conclusion must be this: because to affirm any proposition is to state it exactly as it is. So, to affirm the disjunctive proposition, "Either C is D or E is F" is merely to repeat it.

(8) Practice in Disjunctive Syllogisms

No separate practice in Disjunctive Syllogisms is necessary as they are to be dealt with after being put into the form of hypothetical Syllogisms. It must, however, be remembered that the mere use of "either—or" in the premises does not make a disjunctive syllogism. To be a disjunctive syllogism it must turn upon the disjunction.

1 Mathematics should be studied, if it is either necessary for culture or useful in practical life. It is neither. It should not, therefore, be studied.

This is not a Disjunctive syllogism, but a Hypothetical one. In logical form,

= If Mathematics is either necessary for culture or useful in practical life, it should be studied.
 Mathematics is neither necessary for culture nor useful in practical life.
 ∴ Mathematics should not be studied.
 Invalid : Fallacy of *denying the antecedent*.

2 He did not take Greek in his Degree Course, for all candidates must take either Latin or Greek, and he took Latin.

= He must have taken either Greek or Latin for his Degree Course ;
 He took Latin
 ∴ He did not take Greek for his Degree Course.

Valid, (according to the theory that the alternatives are exclusive and exhaustive): *Modus ponedo tollens*.

(C) The Dilemma

(9) Nature of the Dilemma

A Dilemma, as a reasoning, may be defined as a syllogism in which the major premise consists of *two* hypothetical propositions conjunctively stated; the minor premise is a disjunctive proposition which either affirms disjunctively the antecedents, or, denies disjunctively the consequents stated in the major premise and the conclusion is either a categorical proposition or a disjunctive proposition according as it affirms the consequent or consequents or denies the antecedent or antecedents respectively. Briefly, a dilemma is a combination of a hypothetical major premise and a disjunctive minor premise.

(10) Forms of the Dilemma

(A) When there are two antecedents in the major premise, and the minor premise disjunctively affirms the two antecedents and the conclusion affirms the consequent or consequents, the Dilemma is called "*Constructive.*" (i) It is "*Simple,*" when the consequent affirmed is one, that is, when the conclusion is a categorical proposition. (ii) It is "*Complex*" when the consequents affirmed are two, that is, when the conclusion is a *disjunctive proposition.* (B) On the other hand, when there are two consequents in the major premise, and the minor premise disjunctively denies the two consequents, and the conclusion denies the antecedent or antecedents, the Dilemma is called "*Destructive.*" (i) It is "*Simple*" when the antecedent denied is one, that is, when the conclusion is a categorical proposition.

(ii) It is 'Complex' when the antecedents denied are two, that is, when the conclusion is a disjunctive proposition.'

Thus there are altogether *four* forms of the Dilemma, viz. (1) Simple construetive (2) Complex constructive (3) Simple Destruetive and (4) Complex Destructive.

The following symbolic and conerete examples will illustrate the four forms :—

(i) Simple Constructive

Symbolic :

Either if A is B, or if C is D, E is F

Either A is B or C is D

∴ E is F

Concrete :

If the mill-hands have to work longer or to earn less, they will be dissatisfied; but they must accept either longer hours or reduced wages,

∴ The mill-hands will be dissatisfied.

(ii) Complex Constructive

Symbolic :

If A is B, C is D; and if E is F, G is H,

Either A is B or E is F

∴ Either C is D or G is H.

Conerete :

If the (indebted) farmer goes across the field, he will meet the bull; and if he goes up the lane, he will meet the money-lender.

But he must either go aeross the field or up the lane,

∴ He will either meet the bull or the money-lender.

(iii) Simple Destructive

Symbolic :

If A is B, E is F and G is H
Either E is not F or G is not H
∴ A is not B

Concrete :

If he goes to town he must pay for his railway ticket and his hotel bill; But either he is unable to pay for his railway ticket or his hotel bill.

∴ He cannot go to town.

(iv) Complex Destructive

Symbolic :

If A is B, E is F; and if C is D, G is H
Either E is not F or G is not H
∴ Either A is not B or C is not D

Concrete :

If he were clever he would see his mistake, and if he were candid, he would acknowledge it;
Either he does not see his mistake or he will not acknowledge it:
∴ Either he is not clever or he is not candid.

Out of these four forms, the third one, the complex constructive, is the most common.

(11) Conditions of the Validity of a Dilemma.

The conditions of the validity of a dilemmatic argument are easy to lay down formally but difficult to realise materially.

(1) In the first place, the minor premise and conclusion must either *affirm* the antecedents or antecedent or *deny* the consequents or consequent respectively. (This

is the same requirement as is demanded by the Hypothetical Syllogism.)

(2) Secondly, the minor premise must be exclusive and exhaustive: that is, each alternative must be exclusive of the other and there must be no third alternative. If the alternatives are formally contradictories, they would make a meaningless disjunctive proposition. Therefore, they must be contrary statements together exhausting all the possibilities of the situation. The alternatives are called the "horns" of the dilemma as if of an infuriated bull.

(3) Lastly, the connection or connections stated in the major premise must be true.

It will be noticed that a dilemma, as a *form of reasoning*, must have a statement of alternatives in the minor premise; but the alternatives need not be unpleasant. When they are really unpleasant, the person who has to face the unpleasant alternatives is literally in a dilemma, that is, is in a dangerous *practical* situation.

(12) Refutation and "Rebuttal" of a Dilemma

To refute a dilemma is to show that it violates one or more of the above mentioned conditions of validity. Apart from showing any merely *formal* fallacy like that of denying the antecedent or affirming the consequent, there are three ways of refuting or showing the falsity of a dilemma.

(1) One way is to challenge the truth of the *major premise*, that is, to show that the antecedent or antecedents do not exist or even though they may exist, the stated consequents do not follow from them. In conti-

nuation of the simile of "horns", this refutation is called "*Taking* the dilemma *by* the horns."

(ii) But the fault most commonly is to be found in the *minor premise* which does not really exhaust all the alternatives. Showing this is called "*Escaping between* the horns" of the dilemma. Generally, some relevant alternatives are lost sight of in making the disjunctive minor premise. Jevons has well said, "Dilemmatic arguments are more often fallacious than not." The main reason why they are so is that the minor claims to be, while in fact it is not, an exclusive and exhaustive disjunction. It is seldom possible that two alternatives exhaust all the possibilities. Moreover, complete knowledge of all the possibilities is always difficult and often impossible to attain. It is the knowledge of the *practically relevant alternatives* that can decide the validity of a dilemmatic argument. So material considerations are indispensable to the judging of the validity of a dilemma.

(iii) A very cunning way of showing the falsity of a dilemma is to construct a counter-dilemma with the neglected alternatives, and elicit an apparently opposite conclusion. This is called "*rebutting* a dilemma." The two dilemmas 'rebut' each other, thus revealing the falsity of both. The rebutting dilemma, therefore, though it is consciously intended to show the falsity of the rebutted dilemma, unconsciously shows its own falsity in the rebuttal.

The usual way of rebutting a dilemma consists in constructing another dilemma, in which the *major* premise takes, with the first alternative the opposite of the consequent of the other alternative, and with the second alternative the opposite of the consequent of the first

alternative ; the minor premise is repeated, and the conclusion disjunctively denies the two parts of the first conclusion. It is generally the *complex constructive dilemma* that is rebutted.

The following examples (one symbolic and the other concrete) will illustrate the process of ' rebuttal,' (which amounts to only an unconscious " refutation. ")

SYMBOLIC

If A is B, C is D, and if E is F, G is H
Either A is B or E is F
∴ Either C is D or G is H
The rebutting dilemma =
If A is B, G is not H ; and if E is F, C is not D ;
Either A is B or E is F
∴ Either G is not H or C is not D.

CONCRETE

If I marry, I shall have to take care of another person and if I don't there will be none to take care of me.
But either I marry or don't marry.
∴ Either I shall have to take care of another person or there will be none to take care of me.

The rebutting dilemma =

If you marry, there will be some one to take care of you ; and if you don't, you will not have to take care of another person.
But either you marry or don't marry
∴ Either there will be some one to take care of you or you will not have to take care of another person.

It can be easily seen from these examples that a

rebuttal is not a direct refutation at all, because, refutation must prove the *contradictory* of the original conclusion; and the contradictory of a disjunctive proposition is a *conjunctive* denial of the alternatives, and *not a disjunctive* denial. The conclusion of a rebutting dilemma, however, is not really the contradictory of the original conclusion.

In the concrete example above given, the falsity of the dilemma is due to a *faulty major*. For it is not true that marriage will involve the taking care of another person if that other one is able to take care of one's self; nor is it true that if one does not marry, one will suffer from the absence of a care-taking person, for one may not require being taken care of at all.

No doubt, as an argument, the dilemma is perfectly valid, provided the premises are true and the alternatives exclusive and exhaustive, (no formal fallacy being committed). But as it is difficult to satisfy these conditions and as the dilemma presupposes an exhaustive knowledge of the relevant conditions and practical alternatives, it should be used with great caution. Moreover, a practical situation which is dilemmatic to one person may not be so to another person as the latter might easily 'escape between the horns of' or 'take by horns' the "dilemma."

If there are three, four or more hypothetical propositions in the major premise (and corresponding alternatives disjoined in the minor), the argument is called Trilemma, Tetralemma or Polylemma respectively. But the nature of the reasoning is the same as in the dilemma.

(13) Practice in Dilemmatic Arguments

(A) Faulty Dilemmas

The dilemma, being a powerful weapon in controversy, was paid much attention to when Rhetoric was studied. Some dilemmatic arguments have been handed down from antiquity and have received spec[illegible] All these, being rhetorical devices, are faulty at heart, though glibly plausible on the surface.

I. A special type of the dilemmatic argument is called "*Ignava ratio*" or the "*Lazy* argument." The alternatives are concluded to be, one "unnecessary" and the other 'useless;' e. g.

(i) If the patient is destined to die, it is *useless* to call a doctor, and if the patient is destined to live, it is *unnecessary* to call a doctor;

The patient is either destined to die or destined to live;

∴ It is either *useless* or *unnecessary* to call a doctor.

[*Comments*: This argument is viciated by a *faulty major premise*. In the premise, *all* the alternatives have not been stated. It may as well be that the patient will *live through a doctor's help*. This, which is the most relevant alternative, has not been mentioned at all. Being faulty, the dilemma can be easily rebutted, thus:—

If the patient is destined to die, it is necessary to call a doctor and if the patient is destined to live, it is useful to call a doctor;

The patient is either destined to die or destined to live;

∴ It is either necessary or useful to call a doctor.]

(ii) Similarly, a student who is disinclined to attend college may defend his absence thus:—

"If I am clever, it is needless to attend college; and if I am dull, it is useless to attend college;
But I am either clever or dull;
∴ It is either needless or useless to attend college."

[*Comments*: The mistake of the student, who would thus argue, consists in missing the very important alternatives that (*a*) he might be *not so clever* as to dispense with coaching altogether, or (*b*) *not so dull* as to be unable to receive any instruction altogether.]

Similar to these are dilemmas put forward against (i) the holding of Examinations ("If students are industrious, examinations are unnecessary, and if idle, they are unavailing") and (ii) successful career ("If one studies hard, one will fall ill, and if not, will fail in the the Examination").

If dilemmatic arguments are to be carried on on such lines, there is practically no situation which could not be shown to be dilemmatic, as there is nothing so good in life, but "with some pain is fraught."

2. The *Litigiosus*: (or Protagoras versus Euathlus)

Protagoras, the well known Greek Sophist, agreed to train Euathlus as a lawyer, for one half the fee to be paid at once, and the other half when Euathlus won his first case. Having waited in vain for a long time (as Euathlus was not engaged in any suit), Protagoras himself sued Euathlus for the payment of his outstanding fee, and argued thus,

"Audacious young man, if you win this case, you must pay me, according to the terms of our agreement; and if I win this case, you must pay me, according to the decision of the court. Either you win the case or I; therefore, you must pay me."

The disciple, trained as he was by Protagoras himself, was more than a match for the master. He retorted,

"Doting old man, if I win this case, I am absolved from payment, according to the decision of the court, and if you win this case, I am absolved from payment according to the terms of our agreement. Either I win the case or you; therefore, I am absolved from payment."

[*Comments* : These two dilemmas are excellent examples of "rebutting dilemmas." The fault lies in the vagueness of the major premise. What is the real condition for payment, contemplated by Protagoras? Is it the original agreement or the decision of the court? Once having instituted a suit, Protagoras could not very well argue for going back upon the decision of the court! In these days, such an argument would be treated as "contempt of the court," and severely punished. One can also easily anticipate what the decision of the court would be in such a case. As 'no ground for action' had arisen (Euathlus not having won a case and still refused payment), Protagoras's suit would have to be "dismissed with costs." So really, Protagoras was in the wrong].

3. The *Crocodilus* (or Crocodile vs Mother)

A crocodile seized a child and when its mother approached him with a request to return the child to her, the crocodile consented to do so, if the mother guessed rightly whether he was going to eat the child or not. The mother thereupon pleaded thus :—

"If I say that you are going to eat the child and am right, you must return the child, because I am right; and if I say that you are going to eat the child and am wrong, you must return the child as it is not to be eaten. Now, in

saying that you are going to eat the child, I am either right or worng; therefore, any way you must return the child."

To this the Crocodile replied,

"If you say that I am going to eat the child and are right, you will not get the child because I am going to eat it, and if you say that I am going to eat the child and are wrong, you will not get the child because you are wrong. But either you must be right or you must be wrong; therefore, you will not get the child back."

[*Comments*: Here the minor premise is faulty on account of its vagueness. What is to be guessed rightly? the *intention* of eating or the *fact* of eating? What guarantee is there to prevent the Crocodile from asserting any intention? If the mother agrees to the conditions, she must insist on the Crocodile's intention being communicated beforehand to a third party.]

4. Caliph Omar vs The Custodians of the Alexandrian Library.

Caliph Omar is said to have burnt the Alexandrian Library by putting the following dilemma to its custodians:—

"If your books are in conformity with the Koran, then they are superfluous; and if they are at variance with the Koran, they are pernicious. But they are either in conformity with the Koran or at variance with it; they are, therefore, either superfluous or pernicious."

[*Comments*: Here again the minor premise does not state, with sufficient clearness, the alternatives of the situation. The alternatives stated are not exclusive, as the books could be *in conformity with the spirit*, and, at the same time, *at variance with the letter*, of the Koran.]

5. Similarly, a person may argue dilemmatically about work to be done, thus:—"If I work for my family, I shall be censured by Society and if I work for Society, I shall be censured by my family." But then there is a third course open to him, viz. of doing service to both his family and society without any conflict.

(B) Real Dilemmas

However, there are sometimes really dilemmatic situations:—

(1) The recent King Edward VIII's dilemma is an instance in point. He had to choose between the crown and his beloved.

(2) There is a real dilemma confronting a man who suddenly finds that the house is on fire. If he stays in the house he will be burnt to death; and if he jumps out, he will die of broken ribs. But even here, some way out of the difficulty may be found. For example, if the jump is not from a great height and something soft to jump upon may be made available, he may escape death. In such circumstances much depends upon the presence of mind of the person concerned.

(3) The question of lending money to a friend often creates a nice dilemmatic situation. If you lend money, very often you lose it; and if you don't, very often you lose a 'friend'.

(4) Sometimes, one's public behaviour stands at cross-purposes with private relations. For instance, in giving my political vote, I may have to sail between "Scylla and Charybdis" and be tossed between civil sense and personal gain. But one need not despair; for

public good is not necessarily private evil. The really dilemmatic situations in any one's life are very few and far between.

Questions on Chapter VIII

1 (*a*) Explain the valid moods of the Hypothetical Syllogism and state to what moods of the categorical syllogism they correspond.
(*b*) Which fallacies in the form of categorical syllogism correspond to the fallacies in the Hypothetical Syllogism? Illustrate.

2 *Which are the two interpretations* of the meaning of a disjunctive proposition? How do they affect the nature of the Disjunctive Syllogism? Which interpretation do you accept? Why?

3 Explain, with illustrations, the four forms of the Dilemma.

4 "Dilemmatic arguments are more often fallacious than not." Explain and illustrate.

5 Shew how "rebuttal" of a dilemma is not the same as its "refutation."

CHAPTER IX

RELATIONAL MEDIATE INFERENCE

(1) Nature of Relational Mediate Inference

Some propositions, it has been seen (P. 45), state a relation between two terms, which is more specific than the bare relation of predication (i. e. a relation of mere inclusion or exclusion or of a thing and its qualities). For example "A is to the north of B" states a spacial relation between A and B. An inference from one such proposition to another wherein the same relation is looked at from the other side, is called an inference by "converse relation" (P. 90–91). If *two* or more such propositions bearing on the same system of relations are given, a new relational proposition, connecting extreme elements in the system, can be inferred from them. Such inferences may very well be called "relational" in order to distinguish them from the syllogistic. The name 'Systematic' has been used by some logicians.

The following are a few (out of many) examples of such "relational" mediate inference :—

(1) Most M is P; Most M is S; therefore, Some S is P.

(2) A is equal to B, B is equal to C; therefore, A is

(3) A is greater than B, B is greatet than C; therefore, A is greater than C.

(4) A is before B: B is before C, therefore, A is before C.

(5) B *is* to the west of A; C is to the north of B: therefore, C is to the north-west of A.

(2) Difference between the Relational and the Syllogistic reasoning

It was the view of Aristotle and of traditional Logic that the syllogism and *deduction* are *identical* and that the syllogism is the only form of exact reasoning. As the "relational" infetences ate not less exact, attempts were made, with the above view in mind, to show them as syllogistic infetences. All such attempts, however, ate a fallute, as they create confusion tather than clearness. To Illustrate:

If the inference in Example (1) were to be made syllogisitic, a *major* premise will *first* have to be constructed. Very often, the principle is itself made the major premise. In this case it will be "Any two classes of *which* each·*Includes more* than *half* of *a* third class must partially overlap." The two given propositions will then have to be combined into one so-called minor premise. as "*S* and *P are two classes* of which each includes more than half of a third class" and then to conclude that S and P must partially overlap *i. e.* 'Some S *is* P.' But *in this form*. there is *no* trace of the M class at all! To bring it in, the "major premise" and the "minor premise" may be so drafted as to mention the *M* class. *But why such zeal?* Would *it* not be far better to recognise a non-syllogistic type of inference?

Example (2) will have to undergo similar torturing, if it is to stand as a syllogism: for in the form in which it is stated, it is non-syllogistic, as it has no middle term at all. The (apparently middle) term 'B,' though it is a term in the second proposition, is not really one of the terms of the first proposition, where it is 'equal to B.' So clearly, there are, in the present form, four terms.

Example (3) forms an instance of the famous 'a fortiori' argument. If it is argued that a person who is cruel to his brother must be more cruel still to his cousin, the argument is far more simple than it would be if it is forced into the syllogistic form. In this example, similarly, is is unnecessary to invoke the general principle and make it the major premise.

If Example (4) is made more complicated by mentioning the definite temporal relations and by adding some more members, (as, e. g. "A is 15 minutes before B; B is one hour before C, and C is two hours and a half before D; therefore, A is a quarter and three hours before D"), it will be well-nigh impossible to form the "major" premise. Far better it is to recognise a system of Arithmetic which will determine the sum of the intervals. The same difficulty arises in the case of arguments expressing other relations.

The chief objection to treating the relational inferences as syllogistic is this that such treatment confuses the *principles* of reasoning with the *premises* of reasoning. The relational inferences proceed on certain principles, but the principles are not the data or premises from which they proceed. If the principle were to be made the major premise, then even in the ordinary syllogism, the usual

why they do not engage the attention of the logician as much as the syllogistic reasonings do, is that owing to their varied multiplicity of contents. they do not readily admit of *general* formulas. Mathematical reasonings, where, from three given members of a proportion, the fourth one can be inferred, are "relational" rather than *syllogistic.* Conditional *reasonings*, also, though (not to depart from tradition) they have been called syllogisms, are not strictly syllogistic as they are based on the relationships of cause and effect, which are more specific than mere relations of predication. To torture relational reasonings into the form of syllogisms is to obscure the principles on which they proceed. Syllogism, in short, is not the whole of deduction.

(3) Conditions of Validity of Relational Reasonings

The conditions that must be satisfied by "relational" reasonings,: (to! be valid,) can only be stated in very general terms, as the main condition would be the thorough grasp of the particular system :—(1) The terms given in the premises must be related in the same way i. e. in one and the same sub-sysrem as that of time or space, etc. For example, from, "A is to the north of B" and "C is smaller than B," nothing can be inferred. (2) The data or premises given must be sufficient to enable us to construct the specific sub-system in the general system of the world. For example, from "A is to the north of B" and "B is to the south of C," whether A is to the north or south of C. cannot be inferred. (3) Complete knowledge of the interconnetion of the elements within the system is essential. For example, from "A is a friend (or foe of B)" and

"B is a friend (or foe) of C," one cannot say whether A and C are friends or foes or even unknown to each other.

(4) Examples of Relational Arguments

(i) The book is on the shelf; the shelf is on the table; therefore, the book is on the table.

[*Comments*: The conclusion is not correct in the usual meaning of 'to be on.' If two things are contiguous in space with a third, they are not necessarily contiguous with one another.]

(ii) A is sitting on B's shoulder; B is sitting on C's shoulder: therefore, A is sitting on C's shoulder.

[*Comments*: Incorrect for the same reasons as the above.]

(iii) A is the father of B: B is the father of C; therefore, A is the grandfather of C.

[*Comments*: Correct. The relation is in the system of family relations.]

Questions on Chapter IX

1 "The syllogism is not the whole of Deduction". Why not?
2 Distinguish between the principle on which the syllogism and that on which relational inference proceeds.
3 What conditions must a valid relational inference satisfy?
4 Explain the nature of the following argument:—"If a man love not his brother whom he hath seen, how shall he love God whom he hath not seen?" What special name has been given to this type of argument?

CHAPTER X

THE VALIDITY OF THE SYLLOGISM

(1) Is Syllogism Invalid Inference?

The validity of the syllogism has been challenged by Mill with great vehemence on two closely allied but distinct grounds. One of his contentions is that the syllogism is a *petitio principii* ("begging the question"), as the major premise, in the typical First Figure, *assumes* the truth of the conclusion which the syllogism only makes a show of proving. The second contention is that there is *no new* knowledge obtained by means of the syllogism, (as its conclusion cannot give us anything new that is not contained in the premises) and therefore it is no inference at all. In short, the contentions are :— (i) The conclusion repeats what is stated in the major premise and hence is a petitio principii. (ii) The conclusion repeats what is contained in the (two) premises and hence is no inference at all.

(2) Is Syllogism a Petitio Principii?

In his "System of Logic," Mill says, " It must be granted that in every syllogism, considered as an argument to prove the conclusion, there is a *petitio principii*. When we say, 'All men are mortal; Socrates is a man therefore, Socrates is mortal,' the proposition, 'Socrates

is mortal' is presupposed in the more general assumption, 'All men are mortal.'......In short, no reasoning from generals to particulars can as such prove anything since from a general principle we cannot infer any particulars, but those which the principle itself assumes as known."

Criticism: This contention of Mill's is based on a *particular interpretation of* the *major premise, in fact,* on a particular theory of the nature of universals. It assumes that *all* universals are aggregates of particulars and therefore a particular must be first separately established before the universal is formed. No doubt such a view of *universals was suggested* by the *traditional class-*theory of the import of propositions, the doctrine of the distribution of terms, the formula of the dictum, and the usual form of the major premise. In addition, Mill was led to adopt it by his own philosophical theory that knowledge begins with particular facts, with the observation of individual instances and the universal statement is just a shorthand way of recording the results of a large number of particular observations, in short, that all universal statements are of the enumerative type. If they were, there would be a petitio principii, in the First Figure syllogism. But very few universal propo*sitions are of this type. The real or scientific universal* cannot be of the nature of an aggregate of particulars. It is based, not on the *number* of instances observed, but on the *nature* of the instances, the inter-relationship of elements within a system. Such a universal does not require a separate investigation of all individual

following cases, at any rate, the charge of petitio principii must fail :—

(1) In all cases, where the major premise of a syllogism is a genuine or generic universal, the conclusion is not required to establish the major premise, and therefore, the charge of petitio principii does not hold.

(2) Secondly, where both premises are Singular propositions, the conclusion is not required to establish the major premise. It follows from both premises combined. For example, in "Candidate No. 4 has passed in the examination; A is candidate No. 4, therefore, A has passed in the examination," the major premise is quite independent of the conclusion.

(3) Thirdly, when the major premise is a principle or law, accepted on authority, and applied to a particular case, as, for example, by a judge, the particular case could not possibly have been contemplated by the framers of the principle or law.

(4) Fourthly, if the universal has been previously proved, as in scientific laws, every future application of it is a fresh proposition.

(5) Lastly, even when the universal is an enumerative universal, if at the time of inference, it is only remembered to have been proved, the conclusion is not really required to prove the major premise. For example, having arranged all my Logic-books on a particular shelf, I may afterwards conclude that a particular book, being on that shelf, must be a book on Logic ; or having read in the newspaper, that a particular ship was wrecked and all lives lost, when I learn afterwards that a friend of mine was travelling in that ship, I infer that he must have been drowned. Thus the charge of petitio principii fails.

(3) Is Syllogism no Inference at all?

Mill's second contention against the syllogism is that the syllogism is not an inference at all, as the conclusion is contained in the two premises. But such a charge can be brought against any inference whatsoever. For if the inference is not contained in the premises, it cannot be valid; and if it is so contained, then it is not new. The "paradox of inference" means that infereoce must satisfy two somewhat incompatible conditions. The inference must have novelty; otherwise it is useless; and it must have *necessity*, otherwise it is invalid. Now does the syllogism satisfy both these conditions at once? Mill exaggerates the importance of novelty in the conclusion, and condemns syllogism fur not having it. But a little consideration will show how the syllogism has as much novelty as is consistent with necessity. The novelty exists as regards any premise taken singly; and necessity exists when tbe two premises are taken together. The element of novelty has been unduly stressed by Mill under the influence of his theory of inference. He thinks that all inference worth the name is "from particular to particular." The general proposition is recognised by him only as a shorthand summary of many particulars, and at the most a check on hasty inference, but he does not admit its necessity. He says, "Not only may we reason from particular to particular without passing through generals, but we perpetually do so reason......Years elapse before we learn the use of general language." In support of his view Mill adduces the example of (1) a child's inference from having its fingers burnt by fire to their being burnt by fire aoother time and of (2) the village matron's

inference about the illness of a neighbour's child, (and about its remedy) from the *similar* case of her Lucy. But consideration of those very examples will make clear the essentials of a valid inference. We are in such consideration concerned with the *logical*, and not the *psychological*, process. From this point of view, if the inferences are to be *valid*, the universal principle must be at work, even though it may not be clearly formulated. Even Mill requires *resemblance* or *similarity* between the particular cases; but mere *superficial* resemblance or similarity cannot lead to a valid inference. That is exactly why children and matrons often go wrong. The real basis of inference is a *universal*, whether it is expressly formulated or not. There is a kind of inference from particular to particular; for example, the argument from Analogy. But the argument from Analogy is notorious for never giving certainty. Therefore, if the conclusion is to be certain, there must be a universal premise; and its presence in the syllogism, far from being a superfluity, is a necessary condition of the validity of the conclusion. Hence, the syllogistic inference though very strictly limited in its scope, is not guilty of a *petitio principii*. It is valid inference as it satisfies both the conditions, viz. novelty and necessity.

Questions on Chapter X

1 On what grounds has the validity of the syllogism been questioned?
2 Explain and criticise the view that the syllogism commits a *petitio principii*.
3 What are the requirements of valid inference? In what way is there novelty in the conclusion of a syllogism?

CHAPTER XI

FALLACIES

(1) Meaning of Fallacy

Fallacy means incorrectness in thinking; and as incorrectness creeps into thinking in very subtle ways, fallacy has generallv some plausibility about it. It is a supteme duty of Logic to point out the fallacious ways of thinking in otder that they should be avoided. But how is it ever possible to enumerate *all the wrong* ways of thought? Fot as Joseph has remarked, "Truth may have its norms, but ettot is infinite in its aberrations." However, some of these errors are common and of usual occurrence, and these ate to be mentioned as Fallacies.

A fallacy may be intentional or unintenional. An unintentional mistake (patticulary in the application of the syllogistic Rules) is called a '*Paralogism*'; and a mistake which is intentionally committed, that is to say, an attempt to pass off upon others, evidence or argument which we know or suspect to be unsound, is called a *Sophism*. The word, '*Truism*' is applied to a bogus or hollow argument, that is, something which makes only a show of an argument.

(2) Classification of Fallacies

It is best to adopt Aristotle's classsification of *Fallacies* aod interpret and illustrare them from the modern poiot

of view. Fallacies of special occurrence (e. g. "undistributed middle", "illicit major" etc.) have been dealt with under the respective topics. The General Fallacies fall under two broad divisions viz. (A) *In Dictione*' (or due to language) and (B) *Extra Dictione* (or due to thought). Under the first head are described by Aristotle *six* fallacies, and under the second, *seven*.

(3) Fallacices in Dictione

1 Equivocation (or ambiguity in terms): This fallacy is committed when one meaning is mistaken for another. (In syllogistic reasoning, this often amounts to "ambiguous middle").

Examples

1. What was brought yesterday was eaten today. Raw vegetables were brought yesterday: therefore, raw vegetables were eaten today.

[*Comment*: If the meaning of the first propositfon is to be completely expressed, the words, 'after being properly cooked etc.' must be added to it.]

2. You are not what I am.
   I am a human being
   ∴ You are not a human being.
   [*Comment*: 'What I am' is ambiguous."]

3. The end of life is happiness;
   Death is the end of life;
   ∴ Death is happiness.

[Comment: The word 'end' has two different meanings in the two premises.]

4. When death is, you are not;
   And when you are, death is not,
   ∴ You need not be afraid of death.

[*Comment* : The meaning of 'death' is not properly understood.]

5. *My younger brother was born in January: and I was born in February.*

∴ I was born later than my younger brother.

[*Comment* : The *years* of birth are not mentioned]

6. A porter carried my luggage ;
He is a porter ;
∴ He carried my luggage.

[*Comment* : " A porter " is used as a *Singular* term in the major premise, but as a *General* term in the minor premise].

2 Amphiboly (or ambiguity of structure). This fallacy is committed when a sentence is so expressed that it admits of more constructions than one with consequent differences in meaning.

Examples

1. The Greeks, the Romans, shall conquer.

[*Comment* : This may mean either that the Greeks shall conquer the Romans or the Romans shall conquer the Greeks.]

2. The Duke yet lives that Henry shall depose.

[*Comment* : This may mean either that the Duke shall depose Henry or Henry shall depose the Duke].

3. "*How do you do ?*" "*Do ? Do what ?*" "I mean, how do you feel ?" " How do I feel ? With my fingers, of course ; " " No, no ; I mean how do you find yourself ?" " find myself ? I will tell you next time I lose myself. "

[*Comment* : On every question, a construction, different from the ordinary one is put by the respondent.]

3 Composition : This consists in arguing from the *distributive* to the *collective* use of a term, (that is, in composing together what should be kept separate.)

Examples

1. Every member of the Jury is liable to be mistaken
 ∴ The Jury is liable to be mistaken.

[*Comment* : Though a single individual may go wrong, a group of the same individuals may be right, as the faults of some may be overbalanced by the correctness of the many.]

2. Every man desires his pleasure
 ∴ All men desire the pleasure of all.
 (i. e. the greatest amount of pleasure of the whole community).

[*Comment* : How can one person identify his pleasure with another's ? If it were so, conflicts would never have arisen.]

3. Every incident in this story is very natural and probable : therefore, the story itself is natural and probable.

[*Comment* : It is the arrangement of all the incidents that would decide the quality of the whole story and not each incident separately considered.]

4 Division

This is converse of the fallacy of Composition. It consists in arguing from the collective to the distributive use of a term (that is, in dividing apart what should be kept together.)

Examples

1. The works of shakespeare cannot be read in a day.

∴ 'Hamlet,' which is a work of Shakespeare cannot be read in a day.

[*Comment*: The works of Shakespeare are not to be read in one lot. The reading can only be part by part.]

2. The people of America have a prejudice against Negroes ∴ A who is an American, must be prejudiced against Negroes.

[*Comment*: What is true of a whole people is not necessarily true in the case of a single individual.]

3. A mood of the syllogism which is valid in Figures II and III, *is also valid in Figures I and IV.* *Therefore*, a mood which is valid in Figure II is valid in Figure I (and also in Figure IV).

[*Comment*: It can be easily known that every valid mood of Fig. II cannot be valid in Fig. I: but if if is a mood which is *common to Figure II and III*, then it will be valid in Figure I (and also in Fig. IV.)

5. Accent

This fallacy is committed when a word or words in a sentence, not intended to be emphasised, is emphasised or, when phrases or sentences are divorced from their context, or by, italicising (when quoting) words not originally italicised. Sometimes such changes give a shocking turn to the meaning. It is often by these means that *parody* is effected.

Examples

1. Man proposes and... "*woman* disposes" (woman put in for "God")

[*Comment*: The contrast intended to be drawn between man and *God* is *shifted by an anti-climax* to one between man and *woman*!]

2. *You* can never say what may happen *to-morrow*.

[*Comment* : According as the first word or the last is emphasised, an insinuation is made that *I* can know, or that you may know about the *remote* future.]

3. Thou shalt not bear false witness against thy *neighbour*.

[*Comment* : The word 'neighbour' by being italicised gives liberty to bear false witness against other people, which would be a parody of the Divine Commandment.]

4. He said, "Saddle me the *ass*:" and they saddled him the ass.

[*Comment* : The meaning suffers such a drastic change on account of the confusion between the 'direct object' and the '*indirect object*.' *This may be treated* as an example of amphiboly also. Here, it is the mistaking—intentional it seems—of the accent.]

6. Figure of Speech or Paronymous Terms.

This fallacy is committed when resemblance between ideas is sought to be proved from mere resemblance of words.

Example :

Visible is what can be seen;
Audible is what can be heard;
∴ Desirable is what *can* be desired.

[Comment : The real meaning of 'desirable' is what 'ought to be desired.' The mere structure of words is not at all a safe guide to inference.]

(B) Fallacies Extra Dictione

1 Accident

This fallacy is describ-d as "*A dicto simpliciter ad dictum secundum quid,*" that is, to apply to *special conditions* what is only generally true. The mistake consists in ignoring the peculiar circumstances of the case under consideration.

Examples

1. To charge interest for money lent is quite legitimate.

∴ To exact interest form a friend in distress is quite legitimate.

[*Comment* : A general rule must always be modified in its particular application.]

2. Every man has a right to inculcate his own opinions.

∴ A magistrate is justified in using his power to enforce his own political views.

[*Comment* : The general principle is here not used but *misused.*]

3. A walk is good for health.

∴ A walk in bad weather must be good for health.

[*Comment* : Actual experience will prove beyond doubt the falsity of the inference.]

2 Converse of Accident

This fallacy is described as "*A dicto secundum quid ad dicto simpliciter,*" that is, to assume as a general principle what is true only in some particular respect or under some special circumstances.

Examples

1 The syllogism is useless for increasing knowledge
∴ The syllogism is altogether useless.

[Comment :-The value of the syllogism lies elsewhere than in increasing knnwiedge.]

2. To give help to able-bodied beggars is bad
∴ Charity is waste.

[*Comment :* The generalisation is too drastic.]

3 Ignoratio Elenchi or Irrlevant Conclusion

This means arguing beside the point, or proving something else than what is required to be proved. There are many ways of doing so and special names have been given to them :—

(i) *Argumentum ad hominem,* i. e. arguing about the person rather than the principle. This is a common trick of orators and pleaders. A certain solicitor is said to have handed over a brief to the barrister in this form, "No case. Abuse the opponents." If a speaker in the Assembly arguing against "prohibition" were to say, "The member who has brought this bill was himself a liquor-contractor," he would be commiting this fallacy.

(ii) *Argumentum ad verecundiam*, or Appeal to Authoity. For exampie, to say, "Slavery was regarded justifiable by Aristotle and who is wiser than he ?"

(iii) *Argumentum ad populam*, or appealing to passions or sentiment rather than to reason.

Examples

1. "If this measure is passed, remember, the]Socialists will come in power and will increase your income-tax."

2. "Remember that the sign of my opponent in the election is the grinding machine. Now, do you want such a meek political policy? On the other hand, my sign is the Lion"

3. "Would you like Darwin's theory which makes the ape your ancestor?"

(iv) *Argumentum ad ignorantiam*: or side-tracking, that is, proving a *similar* point and making a show that the required point is proved.

Examples

1. "It is injustice to the intellect of women to refuse them the suffrage; for the reigns of many queens, as our own Elizabeth or Anne, have been famous for literary productions."

2. "You want an *intelligent* clerk. In this connection, I may bring to your notice the testimonials about my honesty and industry".

3. "Well, you ask when I am going to return the loan. But have I ever denied it?"

(v) *Argumentum ad baculum*: i. e. Appeal to physical force, or abusive language.

Example

1 "Will you not deliver the keys of the Safe? Look! I hold a revolver in my hand."

(vi) *Argumentum ad scholam* consists in showing differences of opinion among learned men on the question under issue.

Example

"The suffrage should not be extended; for there is

no unanimity of opinion on the point of the limits of extension."

4 Petitio Principii, or Begging the Question

This fallacy is committed when what is to be proved is itself assumed in the course of the argument. When the argument is somewhat long, the conclusion may be smuggled as a premise and then speciously proved from the premises. When this is done in a short argument, the "*vicious circle*" can be easily detected.

Examples

1. As he is asleep, he is not awake.

2. We know that God exists because the Bible tells us so, and we know that whatever the Bible affirms must be true because it is of Divine origin.

3. Treason never prospers. What's the reason? Why, when it prospers, none dare call it treason.

4. Punishment is brutal because it creates fear, and it creates fear because it is brutal.

5 Non Sequitur, or Fallacy of the Consequent

This fallacy consists in affirming the Consequent (and therefore, the antecedent) or denying the antecedent (and therefore, the conclusion).

Example

If the weather is foggy, the train is late; the train is late; therefore, the weather is foggy.

6 Pro Causa non-Causa, or False Cause

Aristotle must have meant by this, "false premises". It is possible to get a materially true conclusion from

materially false premises. Such an argument, even though the conclusion is true, is fallacious on account of 'False Cause".

For example, the following syllogism :—

All stones are philosophers
Some poets are stones
∴ Some poets are philosohers.

7 Many Questions

This fallacy consists in putting a question with an implication, so that any answer (yes or no) must grant the truth of the implication.

Examples

1. Have you given up telling lies?

[*Comment*: If the respondent says yes, he thereby admits having told lies before; and if he says no, he admits *his continuance of the habit of telling lies!*]

2. Is poverty the cause of crime or *vice versa*?

[*Comment*: Here, again, it is implied that one of the two must be true; but as a matter of fact, poverty and crime might have no causal connection,]

3. Are you a knave or a fool?

[*Comment*: A clever respondent should challenge the validity of the question itself, and make it clear that it is not one question but two, to be answered separately.]

Mentioning the fallacies is, after all, like showing the red danger-signals, and not the white light of the lodestar. Perhaps, perfect thinking, like perfect conduct, is unattainable by man. But there is no justification for consciously wrong thoughts or Sophisms. We can keep

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Appendix

Bombay University Examination Questions from 1941 to 1948.

N. B.—*Pages of this book where answers to the questions may be obtained are mentioned after the questions.*

1941

1. (*a*) "Logic is said to be *formal.*" Explain.
   (*b*) Is it correct to say that Deductive Logic is purely formal and Inductive purely material? 2—4
2. (*a*) Explain with illustrations the distinction between (1) Singular and General; 15 (2) Contrary and Contradictory terms. 20—22
   (*b*) "Connotation and Denotation are inseparable aspects of every term." Discuss. 25—27
3. (*a*) What are the Laws of Thought? Can they be proved? 63; 68—69
   (*b*) *How do the Laws of Thought differ from the Laws of Nature?* 64
4. (*a*) How will you distinguish between a categorical and a conditional proposition? How far can a hypothetical proposition be reduced to a categorical? 35; 60
   (*b*) *Put any three of the following statements in strict logical form, giving in each case the quantity and quality of the proposition:-*

Appendix

Bombay University Examination Questions from 1941 to 1948.

N. B.—Pages of this book where answers to the questions may be obtained are mentioned after the questions.

1941

1. (a) "Logic is said to be formal." Explain.
   (b) Is it correct to say that Deductive Logic is purely formal and Inductive purely material ? 2—4
2. (a) Explain with illustrations the distinction between (1) Singular and General ; 15 (2) Contrary and Contradictory terms. 20—22
   (b) "Connotation and Denotation are inseparable aspects of every term." *Discuss.* 25—27
3. (a) What are the Laws of Thought ? Can they be proved ? 63 : 68—69
   (b) How do the Laws of Thought differ from the Laws of Nature ? 64
4. (a) How will you distinguish between a categorical and a conditional proposition ? How far can a hypothetical proposition be reduced to a categorical ? 35; 60
   (b) Put any *three* of the following statements in strict logical form, giving in each case the quantity and quality of the proposition:-

(i) Not a few sickly persons have lived long.
(ii) We are beaten unless help arrives.
(iii) No admittance except on business.
(iv) Every man is not learned.
(v) Bombay is the only city in India, save Calcutta, which has such a large suburb. 49—53

5. (a) When are propositions said to be opposed? 73
(b) Which of the forms of Opposition really deserves the name, and why? 75, 79
(c) Explain: Of the two sub-contrary propositions both cannot be false but both may be true. 76

6. (a) Define (1) a contrapositive; (2) an inverse; (3) a material obverse. 84, 85, 89
(b) Examine any *three* of the following Inferences:—
(1) Boys love play; therefore old men are averse to play. 89
(2) If all good people are happy, unhappiness is an indication of vice. 84
(3) All Hindoos are Indians; therefore a majority of Hindoos are a majority of indians. 89
(4) If all graduates can vote, then no non-graduate has any such power. 85

7. (a) What is Mediate Inference? How will you distinguish it from Immediate inference? 95
(b) Prove that if one of the premises of a syllogism is particular, the conclusion must be particular. Is the converse of this true? 106—7

8. (a) Show that the second Figure can prove only negative conclusions. 112
   (b) What are the *special features* of Fig. III? 118
9. (a) Determine, with the help of the general rules of syllogism, the number of valid moods that prove an E conclusion.
   (b) Reduce A O O both directly and indirectly. 124, 122—3
10. (a) What are the rules of Mixed Hypothetical Syllogism? On what are they based? *151–2*
    (b) Analyse the nature and validity of any *three* of the following arguments:—
    (1) Mind is active: matter is not mind; therefore matter is not active.
    (2) *If there are parties in the Legislature*, the government will have opposition; but as *there are no parties now, the government* is without opposition.
    (3) As the courageous are confident, we must expect the experienced to be courageous, since the experienced are not without confidence.
    (4) X must be either stupid or poor; but since he is stupid, he must be rich. 155—6; 161
11. (a) What is a Dilemma? Distinguish between rebutting and refuting a dilemma. 162, 165–6
    (b) *How will you refute and rebut the following argument?*
    If we open separate colleges for women, we put back the clock of social progress: but if we do not open such colleges, we deny *higher education to women who would* not attend co-educational institutions.

12. Examine the following arguments and name the fallacies, if any, they contain :—
   (1) In reply to my friend's argument, I need only point out that two years ago he himself advocated the very principle he now opposes. 193
   (2) Everyone ought to contribute to the support of the unfortunate; therefore there is no harm in a law which compels men to do so. 192
   (3) "The idea must be true, for it is so beautiful". "What do you mean by saying that the idea is beautiful?" I mean that it expresses the truth so perfectly. 195
   (4) A little economy would save half our expenses; therefore a greater economy would save all our expenses. 189

1942

1. Determine the relation of logic to other sciences, and in particular to Psychology. 8—9

2. (a) Distinguish between Words, Names and Terms. 14—15
   (b) "A relative term is the name of a related thing." Criticise this definition. 22—23

3. How should we understand the law of inverse variation? Consider the objection to it contained in the remark that the meaning of the term 'baby' does not change with the fluctuations of birth rate. 27—28

4. (a) Explain the fourfold scheme of propositions and the *distribution* of terms in them. 38, 70
   (b) How are the alternatives of a disjunctive proposition related? Give examples. 48—49

5. (a) How would you distinguish a proposition from a sentence in grammar? 33—35
   (b) Put any three of the following propositions into strict logical form, giving reasons for the quantity and quality you assign to them.
   (1) None but those who have felt a wound may jest at scars. (2) Not all your guiles can bring him to this foul deed. (3) Nobleness enkindleth nobleness. (4) What female heart can gold despise? 49·53

6. What is a Law of Thoght? How would you distinguish between a Law of Thought and a law of Nature? 64

7. Determine the relation of the propositions in each of the following pairs and discuss whether in each case the second proposition can be inferred from the first:—
   (i) Only the great can be treated like children.
   None who are not treated like children are great.
   (ii) All who came to scoff remained to pray.. Some who remained to pray are those who did not come to scoff.
   (iii) No person of good taste would prefer Rilke to Shelley.
   Some who prefer Rilke to Shelley are definitely lacking in good taste. 75–85

8. (a) Show that if a premise in a syllogism is particular, the conclusion must be particular. 106
   (b) Determine the mood and figure of a syllogism with an affirmative conclusion, in which the middle term is distributed twice. 142

9. (a) State and prove the special rules of the first figure. 111—12

(*b*) Examine the following arguments:—

(i) If metaphysics consists in meaningless noises he must be talking metaphysics, because no one can understand a word of what he is saying.

(ii) He is by no means a fool though he does not appreciate the play, because those who do not appreciate the play are either ignorant of English or fools and we know that he is thoroughly ignorant of English. 151—60

10. Discuss with examples the difference between rebutting and refuting a dilemma. What is the logical value of mere rebuttal? 165—167

11. Is the syllogism the only mode of deductive reasoning? Discuss in this connection Mill's view that we reason from particulars to particulars. 184—5

12. What is the purpose of reduction? State the following argument in Figure II and reduce it both directly and indirectly:—

Not all who do not resist are non-violent, for the truly non-violent is inspired by love, while some who do not resist evil are not moved by love. 119—20

13. Distinguish the Goclenian from the Aristotelian Sorites. State and prove the rules of the former. What is a double Epicheirema? Give an example. 131, 132, 130

14. (*a*) Distinguish between formal and material fallacies. 187

(*b*) Examine any three of the following arguments, pointing out what fallacies, if any, they contain:—

(i) Pleasure is the chief good or the one thing desirable, as every one desires pleasure, Now since what is seen is visible and what

is heard is audible, what is desired must be desirable. 191

(ii) You will have to pay for your admission since the notice merely says that children of both sexes will be admitted free, and you are certainly not a child of both sexes. 189

(iii) If we wish to serve the interests of the labourers, we must not become familiar with their working and living conditions, because it is said that familiarity breeds contempt. 192

(iv) It is uselesss to study Logic as it does not teach us how to earn a living. 192—3

1943

1. Define Logic, and say in what sense it would be proper to call it "the science of all sciences." 1, 5

2. Explain and examine the view that Intension and Extension vary in inverse ratio. 27—28

3. Define and distinguish between (*a*) Proper names and Designations; (*b*) Absolute and Relative terms; (*c*) Positive and Negative terms; (*d*) Contrary and contradictory terms. 17, 22, 20, 21

4. In what sense do you consider the Laws of Thought to be inviolable? How are the Laws of Identity and Contradiction related? 68-69, 65-66

5. (*a*) What purpose does the copula serve in a logical proposition? 32—3

   (*b*) Bring out clearly the distinction between categorical and conditional propositions. Name and illustrate their varieties. 38,47-48

6. Reduce to strict logical form any *four* of the following propositions, giving reasons for your answers:—

(1) There is none great but God.
(2) Not all snakes are poisonous.
(3) Only ladies are exempted.
(4) When it rains, wise men put on their raincoats.
(5) The contented are seldom unhappy.
(6) What thief would trust a thief? 49—53

7. (a) What is Logical Opposition? What form of Logical Opposition do you consider to be the most satisfactory? 73·75

(b) Answer any *two* of the following:—

(1) Examine: Only criminals should be punished; therefore, all criminals should be punished.
(2) It being known that all intelligent students are not successful, can you infer that no unsuccessful students are intelligent?
(3) "No fair acts are unreasonable." What does this proposition tell you about. (*a*) *unreasonable acts;* (*b*) *reasonable acts?* 75-85
(4) Examine:—A king is a man; therefore, a good king is a good man. 89—90

8. *Describe the nature and structure of a syllogism* and say why the middle term must be distributed at least once in every valid syllogism. 95-96, 100-101

9. What is Indirect Reduction? *Reduce the mood* AOO in Figure II or, the mood OAO in Figure III both directly and indirectly. 120, 124-125

10. (*a*) If the conclusion of a syllogism is O, what must be the premises?

(*b*) State what rules of syllogistic reasoning will be violated if you use.

(1) EAE in Figure III, and (2) IAI in Figure II? 112-113

11. (a) Describe the valid forms of the Hypothetical Syllogism, and discuss the rules that govern them. 151-52

(b) Examine the following argument:—If the armies are poorly led, disaster is inevitable; we may, therefore, conclude that his armies were poorly led, since disaster has overtaken them. 151-60

12. (a) What are the main sources of fallacy in a dilemmatic argument? 164-5

(b) Construct a dilemma to prove that examinations are either useless or superfluous. 170

13. Define a Sorites. State and prove the rules of the *Aristotelian Sorites.* 131, 132.

14. Name and discuss the nature of the fallacies in in any *three* of the following:—

(1) I cannot afford to subscribe to the Famine Fund, the Aid to China Fund and the Red Cross Week: hence, I cannot afford to subscribe to this or that or the other. 189

(2) Since virtue is its own reward, it is superfluous to reward our fighting services for their gallantry. 192

(3) God exists, because the scriptures say that He exists, and you cannot doubt the authority of the scriptures, because they were revealed by God himself. 195

(4) Mr. A says that I have acted against my own principles; but I ask, has not Mr. A acted several times against his own principles? 193

(5) B and C must have met; since A has met B and C has met A. 179

1944

1. Define Logic. Is Logic a Science of Words? If not, How is Logic related to Language? 10,

2. Distinguish clearly between:—
   (1) Word, Name and Term. 14-15
   (2) Concrete and Abstract Terms. 19-20
   (3) Positive and Negative terms 20-22
   (4) Collective and Distributive Terms. 17-18

3. State and explain the Law of Contradiction. Is the Law universally valid? If so, how will you explain the following statements which experience asserts as true?
   (i) This horse is white and not white.
   (ii) The tea is hot and not hot. 66-67

4. Discuss fully the question whether proper names are significant terms or meaningless marks. 25-26

5. (a) Show that the distribution of the predicate depends upon the quality of the proposition. 70
   (b) Reduce to strict logical form any four of the following propositions, giving reasons for your answers:—
   (1) The war may not end this year.
   (2) Only soldiers in uniform are admitted at half rates.
   (3) Few men are not in need of money.
   (4) The older we grow, the less ambitious we become.
   (5) Threats may sadden, but they never convince
   (6) Submarines do not always escape punishment. 49-53

6. Explain the nature of a disjunctive proposition.

Deduce, giving reasons, hypothetical propositions from:— (1) X is either a poet or a philosopher. (2) Mary is either at Madras or at Mysore. 48-49

7. (a) What is Conversion? Is the simple converse of A always fallacious? 81 83
   (b) Examine the following inferences:—
   (i) All air raids are not destructive; therefore, some air raids are. 75-8
   (ii) All irrelevant talk is useless; Therefore, all relevant talk is useful. 89
   (iii) A syllogism is a reason; therefore, a good syllogism is a good reason. 89
   (iv) X is a cousin of Y; Therefore Y is a cousin of X. 90-91
8. (a) Define the nature and the varieties of syllogism.
   (b) Supply premises to prove the following conclusions:—
   (1) Logic must be a compulsory subject of study
   (2) All who beg are poor.

9. Express any three of the following arguments in proper logical form and test their validity:—

(1) Bees are useful little insects, since they gather honey.
(2) He knows a good deal, for he says so little.
(3) No pauper has a vote, but Tribhuvan is rich, so he must have a vote.
(4) Unless I pass, I have no future; but I am sure to pass; my future is therefore assured. 151-60

10. Show that:—
   (a) Two particular premises prove nothing 105-6
   (b) If the major term of a syllogism is predicate

in the premise, the minor premise cannot be negative. 133

11. State and prove the rules that govern the mixed Hypothetical syllogism. 151-52
12. Defioe a Sorites. Show that neither in the Aristotelian nor in the Goclenian Sorites, an O proposition can be a premise. 132
13. What is a Dilemma? What are the conditions of validity in a dilemma? Coostruct a dilemma to prove that war is not a profitable business. 164-5
14. Point out the fallacies, if any, in the following:—
    (1) He must be a generous man, since his family *is known for its generous benefactions. 189*
    (2) You, Sir, once graced this august chair for years and always upheld its dignity; does it become you, now, thus to criticise its present occupant? 193
    (3) Men are entiled to keep the fruit of their labour. Farmers, therefore, must not be compelled to sell their corn to the state. 192
    (4) Inflation makes men rich, since it brings them plenty of money. *195*

1945

1. "Logic is the science which investigates the general principles of valid thought." Discuss. 1-2
2. Explain clearly what you understand by connotation. What terms do you regard as non-connotative, and, why? 23-27

3. (a) Explain the nature of a logical proposition. 32-35
   (b) Express any *Four* of the following statements in strict logical form, giving reasons :—
   (a) Truth alone endures.
   (b) No news is good news.
   (c) Two members of the council are Indians.
   (d) Self-government is not necessarily good government.
   (e) Not all the charters and peace conferences will undo the terrible havoc of the present World War. 49-53
4. Answer any *Two* of the following :—
   (a) Explain the distribution of terms in A, E, I, and O propositions. 69-70
   (b) Define and illustrate Contrary and Contradictory opposition. 75-76.
   (c) What propositions cannot be converted at all, or, not simply ? 81—82
5. Do you regard Immediate Inference proper, or only as verbal transformation ? 92—93
6. Test the validity of any *three* the of following :—
   (a) If it is true that all criticism is not destructive, does it not follow that some criticism is ? 75-6
   (b) A poet is a teacher ; therefore, a great poet is a great teacher. 89-90
   (c) Light is beneficial ; therefore darkness is harmful. 89
   (d) A loves B ; therefore, B loves A. 90
7. (a) Define Figure. How do you determine the number of figures ? 107-8

(b) Show that in the Third Figure the conclusion must be particular. 113

8. (a) Prove that two negative premises yield no conclusion. Is rhe rule universally valid? 102-4

   (b) If the minor premise of a syllogism is O, determine its figure and mood. 140

9. Define a Sorites. Show that in a sorites only one premise can be negative, namely, the last in the Aristotelian, and, the first in the Goclenian. 131-2

10. Distinguish between Direct and Indirect Reduction.
    Reduce O A O in Figure III, both directly and indirectly. 123-5

11. (a) Define a Dilemma, and state the laws of its validity. 162, 164-5

    (b) Express the following argument in the form of a dilemma and test its validity :—
    Moral exhortations are useless; for, good men do not need them; and bad men do not heed them.

12. State any *Four* of the following arguments in logical form, and examine their validity, pointing out the fallacies, if any, involved in them :—

    (a) If he pleads that he did not steal the purse, why, I ask, did he hide it?

    (b) Since every man has a right to inculcate his views, a magistrate is justified in using his powers to enforce his own political views. 192

    (c) His must be a learned discourse, since, he is a member of the Assembly, and the Assembly is a learned body. 189

(d) What is the use of his preaching these ideals with so much fervbur? Has he, we ask, ever practised what he is preaching? 193-4

(e) Romeo must be in love; for is he not seventeen? 192

(f) Most scientists are agnostics,
Most scientists are honest,
∴ Some honest persons are agnostics.

1946

1. Explain the sense in which Logic is a formal and normative sicence. 3-6
2. (a) Explain with illustrations the distinction between any two of the followiog :—
   (i) Singular and General. 15-16
   (ii) Absolute and Relative. 22-23
   (iii) Contrary and Contradictory. 21-22
   (iv) Abstract and Concrete. 19-20
   (b) *Are proper names Coonotative? Give* reasons for your answer. 25-27
3. (a) Distinguish between a logical proposition and a grammatical sentence. 33-35
   (b) Reduce to strict logical form any *four* of the following propositions, giving reasons for your answers :—
   (i) All your anxiety will not save him.
   (ii) Go to America.
   (iii) Members alone can vote.
   (iv) Poona is the only city in Maharashtra, save Bombay, that is a big educational centre.
   (v) Shall we submit to such tyranny as this?

(vi) Not every one is a good judge of his interest. 49-53

4. (*a*) How are the alternants of a disjunctive proposition related? 48-49

(*b*) Express the following as hypothetical propositions:—

(i) Lines are either straight or curved.

(ii) He is either a musician or a painter.

5. Explain the nature and function of the Laws of Thought. Can they be proved? If so, how? 63-65; 68-69

6. (*a*) Explain why a contradictry is preferred to a contrary in refuting an opponent? 78-9

(*b*) Examine any *three* of the following inferences:—

(i) Wherever there is stagnant water, there is malaria: therefore wherever there is malaria there is stagnant water. 81

(ii) A scout is a schoolboy, therefore a good scout is a good schoolboy. 89-90

(iii) All flowers are attractive, therefore all non-attractive things are not flowers. 84-85

(iv) If all lecturers can vote, then no non-lecturers have any such powers. 84-5

Or

(*a*) Distinguish between Eduction and Opposition,, and mention the various forms of Eduction. 80-81

(*b*) Given that "all logicians are thinkers", consider whether the following inferences are legitimate:—

10. (*a*) Define a polysyllogism, and distinguish between a progressive and a regressive polysyllogism. 129

(*b*) *State the following argument in logical form* and examine its validity:—Examiners who are excessively tender with weak candidates are unjust towards the better candidates. For they reduce the standard of the examination, and therefore the value of passing it, even for those who have reached the higher standard.

11. (*a*) Answer one of the following:

(i) Explain why in the mixed hypothetical syllogism there is no valid ground for inference from the denial of the antecedent or from the affirmation of the consequent. 152-3

(ii) What conditions must the premises fulfil in order *that the dilemma be conclusive? 164-5*

(*b*) State any *two* of the following arguments in logical form and examine them:—

(i) If capital punishment were an effective deterrent, there would have been an increase in the number of murders, over a period of years, in those countries which have abolished the death penalty. But this has been shown to be not the case.

(ii) To get a good position in the Civil Service one must either be very clever or else have influential friends. But as he has influential friends, it follows that he is not very clever.

(iii) The Sales-tax must be right because if it

raises prices, it benefits the producers; and if not, it does no harm to the consumers. 151-61

12. State any four of the following arguments in logical form, and examine their validity, pointing out the fallacies, if any, involved in them:—
    (i) To interfere with another man's business is wrong; to sell goods cheaper than another man is to interfere with his business; therefore it is wrong. 192
    (ii) If any business-man takes a holiday, he suffers loss of custom; so that a general holiday is undesirable, as everyone thereby would lose custom. 189
    (iii) When we buy in a foreign country, we get the goods and they get the money; and when we sell in a foreign country, they get the goods and we get the money. How much better, then, to buy and sell in our country, for in that case we retain both the goods and the money. 189
    (iv) Among the whole student body I can think of no one mean enough to do the act the students are accused of doing. 192
    (v) Since space is nothing, it cannot be thought; for a thought must be of something that is. 187
    (vi) Some prejudices must be rational; for they are shared by many people, as rational opinions always are. 192

1947

1. Define Logic. Is Logic a Science or an Art? How is Logic related to Psychology? 1-2,5-7,8-9

2. Distinguish with examples between
   (a) Word, Name and Term. 14-15
   (b) Collective and distributive use of terms. 17-18
   (c) Connotative and non-connotative terms. 25-26
3. (a) What do you understand by the connotation and denotation of terms? 23-24
   (b) Examine the view that the denotation and connotation of a term vary inversely. 27-28
4. (a) Discuss the nature and function of the copula in a logical proposition. 32-33
   (b) Frame a concrete disjunctive proposition and reduce it to corresponding hypothetical and categorical forms, showing their quality and quantity.
5. (a) Explain the fourfold scheme of classification of propositions and the distribution of terms in them. Discuss the limitations of the scheme. 38, 70
   (b) Reduce to logical form any *three* of the following :—
   (1) Nothing can bring you peace but the triumph of principles.
   (2) A few scientists are religious.
   (3) No admission without permission.
   (4) Barking dogs seldom bite.
   (5) Not all those who are not with us are against us.
   (6) Who will deny India's right to freedom? 49-53

6. State and explain the *Law of Identity*. Is the Law of Contradiction only a negative expression of the Law of Identity? Give reasons for your answer. 66-67
7. (*a*) Define Opposition. Distinguish with examples between Contrary and Contradictory Opposition. 73, 75-76
   (*b*) Give the contrary and contradictory opposites of any *two* of the following:—
   (1) Birds of the same feather flock together.
   (2) All who seem to be honest are not really so.
   (3) Most men are selfish.
   (4) None can refute your argument. 49-53
8. (*a*) *Is Immediate Inference inference proper?* 92-3
   (*b*) Give, wherever possible, the contrapositive and inverse of any *three* of the following:—
   (1) Nothing venture nothing have.
   (2) Every saint is a gift of God.
   (3) Life is not always a bed of roses.
   (4) Some books are costly. 84-5
9. What is a Syllogism? Does it involve a *petitio principii*? Given reasons for your answer. 181-3
10. Define Figure and Mood. Determine by general syllogistic rules the valid moods in Figure II. 107-8
11. (*a*) Explain why O cannot stand as a premise in the *First Figure*, as a *major premise in the* Second Figure and as a minor premise in the Third Figure. 111-3
   (*b*) If in a valid syllogism the major premise is particular and the conclusion negative, determine the mood and figure. 140

12. (*a*) What is an Enthymeme? Express the following in proper syllogistic fotm:—
    (i) A physician, after all, is a human being, liable to *err*. 127
    (ii) He is too sincere a pattiot to betray his country for selfish ends. 126–7
    (*b*) Show that in a Sorites only one premise can be negative, namely, the last in the Aristotelian, and the first in the Gocleoian form. 132
13. What is a Dilemma? Distinguish between a rebuttal and a refutation of a dilemmatic argument. 162, 165·6
14. Analyse any *four* of the following arguments, pointing out the fallacies, if any, contained in them :
    (*a*) The holder of some tickets in the lottery is sure to win a prize, and as I have some tickets in the lottotv I am sure to win a prize. 187
    (*b*) You cannot judge by appearances. Mr. X looks honest. Therefote, Mr. X is a rogue. 192
    (*c*) The Assemblv has passed the Public Safety Bill. Therefore, A, who is a member of the Assembly, must have voted for it. 189
    (*d*) The doctor deserves to be censured, for he deliberately told an untruth to his patient regarding the exact nature of his disease, and, as you know, to tell an untruth is dishonourable. 192
    (*e*) Who can deny that this measure will improve the lot of our fellow-citizens, when we reflect thar it will raise the standard of comfott in every house? 195

(f) We must recognise the right of Harijans to enter our temples, for are we not exhorted to do so by Mahatma Gandhi? 193

1948

1. "Logic is the science of sciences". Explain. Is Logic also an Art? 5, 6-8
2. "Every term has both denotation and connotation." Do you agree with this view? Discuss it with reference to the following terms: (i) Fairies (ii) John (iii) Squareness, 25-26
3. Distinguish between a logical proposition and a grammatical sentence. What is the precise function of the copula in a proposition? 33-35
4. Explain the nature and function of the Laws of Thought. Can they be proved? 63-4, 68-9
5. (a) Is Immediate Inference inference at all or merely a different way of stating the same fact? 72

   (b) State the relation between the two propositions in each of the following pairs. Can the second proposition in each pair be validly inferred from the first?

   (i) Hatred invariably breeds hatred
   Love can never be the cause of hatred.

   (ii) No politician can resist the temptation of power,
   All who seek power are politicians.

   (iii) Not all friends are to be trusted
   Not all persons who are untrustworthy are unfriendly. 75-85

6. (a) Distinguish between Eduction and Opposition and mention the various forms of Eduction. 80-81
   (b) State what can be asserted as to the truth of a proposition from
   (i) the falsity of its contrary
   (ii) the truth of its sub-contrary
   (iii) the truth of its obverse. 75-85
7. (a) Given the quantity or quality of a proposition, what can you say about the distribution of terms? 70
   (b) State the following propositions in strict logical form and give the inverse where possible:
   (i) An atheist is not necessarily immoral.
   (ii) Nationalism inevitably leads to war.
   (iii) You cannot serve God and Mammon. 84-5
8. (a) What is a Syllogism? What is meant by calling it mediate inference? 95
   (b) Determine the mood and figure of a syllogism in which the major term is distributed in the major premise but is undistributed in the conclusion. 140
9. (a) Why is Figure I regarded as the perfect figure? 116-7
   (b) Reduce AEE in Figure II both directly and indirectly to Figure I. 120-5
10. Put the following arguments in proper syllogistic form and test their validity.
   (a) How can you assert that ideologies are

harmful when you know that nothing that is harmful will be accepted by everybody and that no ideology is ever accepted by everybody ?

(b) Since violence is always an evil and evil is sometimes productive of good, violence may occasionally lead to good results.

(c) You must admit that not all failures are to be condemned, when you yourself say that nothing that involves labour is to be condemned and that many who fail have laboured at their task. 162, 165–6

11\. (a) What are the valid moods in Mixed Hypothetical Syllogisms ? 151–2

(d) Test the validity of the following argument:- You cannot say that all philosophical theories are sound, for if they were, then some would be accepted by a majority of thinkers ; but we know very well that none is accepted by a majority of thinkers. 154–5

12\. (a) What is a Dilemma ? "The plan of meeting a dilemma by another dilemma is a purely rhetorical device and has no logical efficacy." Explain this statement distinguishing between rebutting and refuting a dilemma. 162, 165–6

(b) Rebut the following dilemma ;—
If they join in the public rejoicings, they are inconsistent ; if they do not, they are unpatriotic ; but either they do or they do not ; therefore, they are either inconsistent or unpatriotic. 169–70

13\. (a) What is Sorites ? Distinguish the Aristote-

lian from the Goclenian Sorites. Give illustrations. 131–132

(b) Express the following in the form of an Aristotelian Sorites and test its validity:—
Wars must always lead to further wars, because when people become inhuman they abopt the law of the jungle, which means that they live in a state of perpetual warfare. Now people become inhuman when they are brutal and ruthless and it is obvious that wars must necessarily release forces of brutality and ruthlessness. 148

14. Analyse any *four* of the following arguments pointing out the fallacies, if any, contained in them:—

(a) Books are a source both of instruction and amusement. A table of logarithms is a book: therefore, it is a source both of instruction and amusement. 192

(b) What would our ancestors say to tha Divorce Bill? How does it agree with their experience? Are we to put the wisdom of today in competition with the wisdom of centuries? 194

(c) Four and three are six and one, therefore, four is six and three is one. 189

(d) "Is Plato different from Socrates?" "Yes." "Is Socrates a man?" "Yes." "Then Plato is different from man." 187

(e) We do not believe in the soundness of his criticism. Certainly he is the least fitted to criticise. Those who live in glass houses ought not to throw stones at others. 193

(f) "What man has done man may do." So we may still take heart in our national misfortune as each one of us is capable of doing what Mahatma Gandhi did. 192

(g) Who can deny that this measure will improve the lot of our people when we know that it will raise the standard of comfort in in every home? 189

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A Hand-book of Logic

[Part II]

★

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CHAPTER 1

PROCESSES AUXILIARY TO INFERENCE

(A) The Predicables

(1) Introductory

Inference, as has been pointed out in Chapter I of Part I, cannot be a purely formal affair. Which inference, from a given proposition or observed fact, will be correct and which not, must depend upon the actual content of the proposition. Material knowledge, or knowledge of the content, is therefore quite necessary before any inference worth the name is attempted. As the question of material knowledge is one about which Inductive inference is largely occupied, certain processes depending on material knowledge may be indicated before the nature of Inductive inference and its methods are studied. These auxiliary processes are (1) The Predicables (2) Definition (3) Division (4) and Classification.

(2) Meaning of the Predicables

The Predicables, or the Heads of Predicables, are the various ways in which the characteristics expressed in the

predicate are regarded as belonging to the subject, in an affirmative proposition.

(3) Aristotle's classification of the predicables

Two well-known classifications of the Predicables have been handed down to us, one given by Aristotle and the other given by Porphyry who was a commentator on Aristotle. Aristotle mentions *four* Heads of Predicables viz. (1) *Definition* (2) *Proprium* (3) *Genus* or *Differentia* and (4) *Accident*.

Aristotle bases this classification on the fact of the proposition being simply convertible or not being simply convertible. If it is simply convertible, the predicate must express either the whole essential nature of the subject, in which case, it is the definition, or must express something, which though not the essence of the subject is peculiar to it and is an inseparable concomitant of it, in which case, it is the proprium (property) of the subject. If the proposition is not convertible simply but by limitation the predicate might express only a part of the definition, that is, is a genus or differentia, or the predicate might state something which is no part of the essence, nor peculiar to it, that is, is an accident.

ILLUSTRATIONS

1. Definition:—A triangle is a three-sided rectilinear figure.
2 Proprium:—1. Equilateral triangles are equiangular.
   2. Man is a cooking animal.

3 Genus or differentia:–

1. Cows are animals (Genus).
2. Man is rational (*Differentia*).

4. Accident:— Men are ambitious.

(4) Purphyry's List of the Predicables

Porpbyry gives a revised classification which has become the standard one. He enumerates five Heads of Predicables– (1) Genus (2) Species (3) Differentia (4) Proprium (5) Accident. They may be defined as follows:—

(1) A Genus is any wider class which is made up of narrower classes; for example, a triangle is a figure. (2) A species is any narrower class included in a genus; for example, Socrates was a man. (3) A differentia is the attribute or attributes by which one species is distinguished from others contained under the same genus; for example, man is rational. (4) A proprium is an attribute which is not essential but which follows from the essential either as effect from cause, or as conclusion from premise; for example, Equilateral triangles are equiangular. The essence or essential attributes of a thing are all those attributes without any of which the thing will cease to be what it is. It is the irreducible connotation of a term. (5) An accident is an attribute which is neither part of the connotation nor is necessarily connected with it; for example, Negroes are black.

(5) Comparison of the two Lists of Predicables

The following differences between Aristotle's List and Porphyry's are noticeable:— (1) Definition is omitted from the latter (2) Species and Differentia are added as separate predicables (3) The meaning of proprium and genus is somewhat changed.

(1) The reason why definition is omitted from Porphyry's list is that he thought of the relation between subject and predicate as one between two classes, that is, he was primarily thinking of denotation (on which are based division and classification), whereas Aristotle was primarily thinking of the connotation (on which is based definition). According to Porphyry, definition is the same as genus and differentia put together and therefore is not a separate head. (2) 'Species' was not mentioned by Aristotle, because according to him, it was always the subject of the proposition and could not stand as the predicate. The theory of predicables was applied by him only to a proposition with a general term as its subject. However, in a proposition like " Socrates was a man ", the predicate is clearly the species to which the subject belongs. (3) Genus and species were treated by Porphyry as relative to one another, that is, as logical predicates. According to Aristotle, genera and species were fixed classes in biology. They had no application beyond that science. According to Porphyry, they are given a wider application so that in a proposition like " A table is a piece of furniture ", the predicate may be said to be a genus. So also, one and the same term may have a relation of genus to a lower class, but of species to a higher class. For example, 'mammals' is a genus in " Whales are mammals " but species in " Mammals are vertebrate animals. " Porphyry also made a change in the meaning of ' proprium.' It is not merely a " peculiar attribute " according to him, but one that must necessarily *follow* from the essential qualities. Hence, man's ability to cook, which, according to Aristotle is a proprium of man, being peculiar to man, is an accident according to Porphyry, unless, it is seen to be the necessary consequence of man's rationality. Equiangularity is a proprium of an equilateral triangle because it follows from the essence.

Later logicians have introduced a distinction among accidents as (1) *inseparable* and (2) *separable.* An "accident" is said to be inseparable when it belongs to all the members of a class or belongs to the individual (in the case of a singular term) at all times. It is said to be separable when it belongs to some members of a class or belongs to the individual (in the case of a singular term) at some times. For example, the possession of moustaches is an inseparable accident of men and wearing a suit of blue serge would be a separable accident. In the case of an individual, say, Shivaji, his birth at Shivneri would be an inseparable accident, but his wearing the turban would be a separable accident. The distinction between separable and inseparable accident is very difficult to apply and is of minor importance. Similarly, it is sometimes extremely difficult to say whether the given attribute is a proprium or an inseparable accident.

(6) Some allied terms defined

(i) The term "summum genus" is used to describe a class which cannot be included as a species in any wider class; for example, Being or Substance.

(ii) The term "infima species" is applied to a species which cannot have subordinate species but only individuals ; for example, man.

(iii) A line of divisions beginning with a summum genus and ending with an infima species is called a "predicamental line"; for example,

Figure (Summum Genus)

Regular Irregular

Bounded by straight lines Bounded by curved lines

Plane Solid

and the plane figures into triangles, squares, etc.

(iv) One such predicamental line, starting from 'Being' and passing through 'Corporeal' 'Animate' 'Sensible' and reaching the infima species 'Rational' (as shown in the tables below) is called "Porphyry's Tree" because Porphyry originated it.

Being or Substance

Corporeal (Bodies) — Incorporeal (Angels, etc.)

Animate (i. e. Living Bodies) — Inanimate

Sensible (Animals) — Insensible (vegetables, etc.)

Rational (Man) — Irrational (Lower animals)

Here, "Being" is the Summum Genus and "man" is the infima species under which only *individuals* like "Socrates, Plato, Aristotle" may be indicated but no species.

(v) The classes intermediate between the summum genus and infima species may indifferently be called 'subaltern genera or species.' With respect to lower classes they are genera; and with respect to high classes they are species.

(vi) By "proximate genus" is meant the genus next above the given species, as distinguished from the remote ones; for example, in the illustration, "animals" is the

proximate genus, and "*living* bodies" a *remote genus*, of "man".

(vii) "Generic resemblance" or "Generic difference" means that resemblance or difference which the species has on account of its genus; for example, the isosceles triangle generically resembles the scalene triangle, and generically differs from the square.

(viii) "Specific resemblance" or "Specific difference" means that resemblance or difference which the species has on its own account, for example, one isosceles triangle has a specific resemblance to another isosceles triangle and has a specific difference from an equilateral triangle.

(ix) Similarly, "a generic property" is one which belongs to the species on account of its genus; for example, the property of having the three angles equal to two right angles is a generic property of an isosceles triangle; and

(x) A specific property is one which belongs to the species on its own account; for example, the equality of the angles at the base is a specific property of an isosceles triangle.

(7) Importance of the Predicables

The chief importance of the Predicables consists in making the thought clearer by means of judging the actual material relation between the subject and the predicate of a proposition. Inference must always take into account the material conditions; the Predicables render it easy by drawing pointed attention to the relation between the two sides of a proposition. Out of the five Heads, the genus and differentia are so important for definition that the two are held by some to be identical with definition. As definition has an all-pervading importance, genus and differentia acquire their importance from their close connection with

definition. 'Proprium' (in Aristotle's meaning) is helpful in enabling us to simply convert an A proposition. Species and Accident are especially useful in simplifying the process of "Division." Species indicates where to stop and Accident (particularly, separable accident) suggests where to begin, the divisions.

The theory of predicables is applicable only where the subject and predicate point out two really different things. If the proposition is merely a "verbal" one, showing identity between the subject and the predicate, the theory of predicables is inapplicable; for example, in "Caledonia is Scotland" or "Cicero is Tullius". Also, the theory of predicables is strictly applicable to affirmative propositions only. When some attribute is being *denied* of a thing, it is immaterial to know what kind of attribute is being denied. It is thought that the head of predicables in a negative proposition is the same as it would be, if the same attribute were to be affirmed. For example, in "Some politicians are not honest", it is said, honesty being a separable accident of politicians, a "separable accident" is here *denied* of the subject. Such an interpretation becomes misleading. Supposing the proposition were "He is not idle," would it not be misleading to say that "an inseparable accident" is here denied of him; or if the proposition were "A table is not a bird", how could the head of the predicable be determined?

(8) Examples

1 Whales are mammals [Genus].
2 Most men smoke [Separable accident].
3 Knowledge is power [Proprium]
4 Xantippi was the wife of Socrates [Inseparable accident]

5 Monkeys are mischievous [Inseparable accident].
6 Aristotle was a philosopher [Species, *logically*]
7 Savages are cannibals [Differentia].
8 Man is a laughing animal [animal is a genus; laughing, an inseparable accident. According to Aristotle, it would be a proprium.]

QUESTIONS

1 Mention and compare the two lists of predicables, viz. those of Aristotle and Porphyry.
2 Discuss the logical importance of the Heads of Predicables.
3 Explain and illustrate the following terms:—
   (1) A predicamental line (2) Separable accident
   (3) Generic difference. (4) Proximate Genus.
   (5). Infima Species (6) Porphyry's Tree.

(B) Definition

(1) Definition of Definition

To define a thing is to state explicitly all the essential qualities of the thing defined or to give the whole connotation. Definition is the mental analysis of the connotation; and as the connotation of a thing is not rigidly fixed but depends upon the particular context, the same thing may be defined in different ways according to the different point of view. For example, water may be defined by an ordinary man as a liquid that allays one's thirst, by a farmer as a liquid that makes his crop grow and by a chemist as a combination of hydrogen and oxygen in the proportion of two to one. Similarly, " man " is ordinarily defined as a rational

animal; philosophically, he may be defined as a finite—infinite being; and ethically as "a political (social) animal". (Aristotle) Definition, from the logical point of view, is to be identified with the *scientific definition* or one that is made not in any special context but in the most general way of 'knowledge for its own sake'. Legal definitions are the exact opposite of scientific definitions. They only state the *sense* in which the term is used in a particular context. Scientific definitions, on the other hand, have to express the most *general* connotation of the thing defined.

(2) Definition and Description

Definition, in the scientific or logical sense, must be distinguished from description. Description is often very loose. Definition, on the other hand, must be exact and brief. Description generally consists in setting up before our eyes a mental picture of the thing; definition in giving us a definite concept. For example, a fort is described by a novelist, but is defined by a military officer. Description appeals to imagination and emotion, definition to thought and intelligence. The rainbow is described by the poet, but is defined by the physicist. Description, in the language of the predicables, is based on accidents and propria; definition on genus and differentia. Even then, no hard and fast line can be drawn between description and definition. For as description becomes more and more exact it approaches definition. In fact, description may be considered as an imperfect attempt at definition which is its ideal. Hence, some descriptions are far off from definitions, but others come very near. The poetic descriptions are farthest off from definitions; but the enumerative, or matter of fact, analytic descriptions come very near to definitions. Definitions because they have to be more accurate are more difficult to frame. The more common-

place the thing, the more difficult it is to frame its definition. A hat or a chair can be easily described, not so easily defined. Sometimes, the definition can consist only in giving a detailed description. For example, the only way of defining a lion (except in strictly biological way) is by giving an analytic description of its structure and habits, etc.

(3) Importance of Definition

The importance of Definition, though recognised by Socrates and Plato was fully understood by Aristotle who observes, " Definition is both the beginning and the end of scientific knowledge ". It is the beginning in this sense that unless the connotation of the thing under investigation is made definite in the beginning, there can be no starting point for future enquiry. Of course, the early definition is generally concerned with the prominent rather than the essential qualities of the thing; but at any rate, some qualities are to be seized upon at the start and afterwards rejected, supplemented or modified by further investigation. Definition comes at the end of scientific knowledge in the sense that definition being the goal of science, a full and complete definition of the thing under investigation can be framed only when the knowledge is complete. Full knowledge comes last, and therefore, a completely satisfactory definition is the final result of scientific inquiry. With the progress in knowledge, our definitions are always undergoing a change for the better. Definitions thus form a good index to the stage of knowledge and civilisation. As our knowledge of the qualities of things is always growing by means of discoveries, " to obtain perfect definitions is practically impossible." Discovery and Definition go hand in hand.

the business of discovery." It is also true to say that "Some definitions (the early ones) are provisional and progressive, while others (given at the end of 'an enquiry) are final." However, very few definitions are really final. Perhaps only in mathematics do we have definitions which are the same for ever. As definition depends on discovery, only the investigator is fitted to give definitions. The content of the defioitions must be supplied by the expert. All that logic can do is to suggest rules for the *formulation* and exact *expression* of definitioos, not for their discovery.

(4) Rules for the formulation of Definitions

If a definition is to serve its proper purpose which is to make the suhject easier to be understood by being assimilated to pre-existing knowledge, it must ohserve the following rules :—

RULE I

The defioitioo must state the most essential qualities; otherwise, as already noted, it will he a mere description. The following tests are applied 'to determine the essential qualities. (a) Essential qualities are those without any of which the thing could not be what it is and (b) are those which are not themselves derivative, but from which most other qualities are derived. For example, "Man is a laughing animal" commits a breach of this rule. 'Laughing' though it is a quality only of mao, is not man's essential quality. If definition is to be accurate, it must hit upon the most important attrihute. Hence, "Man is a rational animal" is the recognised definition.

RULE II

"The definition and the thing defined must he simply convertible;" that is, from the point of view of denotation,

it must be identical for the term defined and the terms defining. A breach of this rule makes the definition 'too narrow' or 'too wide'. As connotation and denotation vary inversely, a definition becomes *too narrow* (that is, less denotative) when it states more than the connotation. Some things which properly belong to the class denoted by the subject are omitted if larger connotation is stated, as by stating the qualities of a particular species in addition. Illustrations from mathematics are very convincing. If a triangle is defined as a three-sided rectilinear figure, having two angles equal, it is a too narrow definition, because of all the species of triangles, it is restricted to only one–the isoceles–and the others are omitted. On the other hand, when the definition states less than the entire connotation, it becomes *too wide*. Things that do not properly belong to the class defined are included if sufficient connotation is not stated, as by stating the genus only without the special qualities of the species defined. If a triangle is defined as "a rectilinear figure," it is a too wide definition because figures which have more sides than three will be included.

A definition may commit both breaches at once, may be too narrow and too wide at the same time. For example, "A rupee is a coin made of silver" is too narrow as the rupee in paper currency is omitted, and too wide as a shilling may be included. The fault most often committed is that of shortage of connotation, that is, of making the definition too wide. "Logic is the science of thought" is too wide as the specific function of Logic has not been told, thus allowing psychology to enter into the definition.

RULE III

"The definition should not be obscure" If it is, the main purpose of the definition, viz. of making the meaning

easily understood, is frustrated. The definition should not be "obscurum per obscurius" (*defining the obscure by the more obscure*). Obscurity may arise in these ways (1) By means of ambiguous or vague expressions. For example, "Capital is that with which one starts business" is so vague that what is exactly meant is not clear at all. (2) By the use of metaphorical or figurative expressions. For example, "The camel is the ship of the desert" does not convey scientific knowledge. (3) By the use of unfamiliar and formidable expressions. For example; "Flee is an apterous hexapod." leaves us not a bit wiser on the question of the nature of fleas. Dr. Johnson's definition of Net, given in his dictionary, will serve as a striking illustration of this last fault. It ran thns, "Net is a reticulated fabric, decussated at regular intervals, with intervals between the decussations".

However, a definition ought not to be condemned on the score of obscurity, if though obscure to laymen, it is sufficiently *significant* to the people *directly concerned*. Scientific definitions are often obscure to ordinary men but very useful in the respective sphere. For example, the physicist's definition of weight as equal to mass $\times\ g$, (where g meanes acceleration due to gravity) is quite a sound *definition*. So also, the *chemist's definition of water* as H_2O.

RULE IV

A definition may not use, explicitly, or implicitly, the term to be defined. If it does, it is called '*circulus in definiendo*' or definition in a circle. So long as the term is repeated in the definition, no light is thrown on the nature of the object and we are just where we were. To define sensations as impressions on the mind and mind as a collection of impressions leaves us in the

dark about the meaning of both sensations and mind. Similarly, to define cause as that which produces an effect and effect as that which is produced by a cause is to define in a circle.

However, mere repetition of one word need not detract from the merit of the definition, if the word repeated is not the important part of the term defined. For example, "An equilateral triangle is a triangle whose three sides are all equal" is quite a good definition, because the term defined is not triangle so much as *equilateral* triangle.

RULE V

The definition should not be negative where it can be positive. The main purpose of a definition is to state what the thing is, not what it is not. As a rule, terms should not be defined by their contraries or contradictories. For examples, "Peace is the absence of war" "Waking is the opposite of sleeping" are bad definitions. However, terms which are negative in their tenor are appropriately defined in negative terms. For examples, "Darkness is the absence of light" and "Indivisible is what cannot be divided" are the only possible definitions of the terms concerned and therefore are admissible though they are negative.

RULE VI

The definition should not state anything superfluous. This rule is already implied in Rules I and II. If something superfluous is added, it becomes too narrow *by suggestion*. For, example, "Man is a featherless rational animal" makes it appear as if there are feathered rational animals. The word 'featherless' is superfluous and misleading. Brevity is the soul of wit and so of definition.

(5) The doctrine of the indefinables

The doctrine that there are some terms which are indefinable arises from the traditional theory of definition as made up only of genus and differentia. If a thing cannot properly be brought under a class and its difference from cognate species told, it is held to be indefinable. From this point of view, the following four kinds of terms are called "Indefinables." (1) Summum Genus, like Being or Substance, as there can be no higher genus for it. (2) Elementary sensations like blue, hot etc. or elementary mental states like pleasure, pain etc as being too simple, their meaning cannot be adequately communicated to others. (3) Terms of complex conception, like capital, rent, education, civilisation, etc, which are so extensive in meaning that *it cannot be accurately fixed; and (4) Proper* Names, as they have no connotation at all. But if Definition means nothing more than the determination of the thing in its system formed by the thing along with allied others, and if even Proper Names have connotation, then there seems to be no reason why any thing or person should be *held to be indefinable.* For example, " *Sambhaji* was the eldest son of Shivaji " can work as a good definition of him. It may be called a description; but *really no hard and fast line can be set up* between the two; and failing a better definition, description, like the above, must be treated as definition. Similarly, sensations of heat, pleasure etc. can be defined by means of genetic definitions (for which see below, under Types of Definitions). An object which is so singular that there is no other object like it and thus baffling all attempts at its definition is said to be *sui generis*, as for example, the rings of Saturn. However, even in such a case, a negative definition can be framed and must be accepted.

(6) Nominal (or Verbal) and Real Definitions

The question as to what is defined, the thing or the word, has led to the distinction between Nominal or Verbal and Real definitions. This distinction was first made by Aristotle and coincides with his distinction between the definition at the beginning and that at the end of scientific enquiry. It is thought that a nominal or verbal definition states the meaning of the word, whereas the real definition states the qualities of the thing. Mill maintains that all definitions are nominal, that all definitions are analytic, identical, verbal propositions. The dictionary meanings, for example, it is contended, are all verbal. Particularly, grammatical definitions like " Tigress is the feminine of Tiger," " Genera is the plural of genus " are quoted as illustrations of verbal definitions. A little consideration, however, will show that even these are not merely verbal; for in them it is not the word that is defined but its grammatical structure or formation. It is wrong to say that the mere word is ever defined. Even the dictionary-definition states the meaning of the objects indicated by the word. In grammatical definitions like the above, the grammatical structure of the word is the objective meaning defined. The controversy can be brought to an end by saying that it is terms that are defined, that is, names having meanings in some system. Hence, all definitions are, in a sense, real..

(7) Types of Definitions

Definitions, as is now clear, may be made in a variety of ways. Some of these types have been given specific names.

(1) Definition " per genus et differentia," (Definition by genus and differentia), sometimes also called the *Synthetic* definition, consists in stating the proximate genus and adding the differentia to it In traditional logic, this

was the only recognised type of definition, definitions in other ways being all damned as mere descriptions. But this itself is a very imperfect method of definition. Firstly, it is based on classification (or the denotative aspect) which does not necessarily express the essential nature of the thing classified or defined. The roseflower by being defined per genus et differentia is far from giving any material details. Secondly, a definition of this type presupposes knowledge of the proximate genus and would therefore be meaningless if the proximate genus is not already known ; for example, the nature of the isosceles triangle cannot be understood, by means of such a definition, by one who is ignorant of the meaning of triangle. Thirdly, this view leads to the theory of the 'Indefinables' by making a higher genus an essential factor of the definition. The summum genus, therefore, is indefinable, according to this theory. There are no doubt one or two advantages possessed by this method of definition, viz. (1) It renders identification of the object among others extremely easy and (2) is also *formally* faultless (as avoiding the fault of being too narrow or too wide); but it has very little scientific value. (2) A *genetic* definition is one which describes the mode of generation or production of the kind of thing defined. Such definitions are very common in mathematics; for example, "A sphere is a solid figure formed by the revolution of a semi - circle about its diameter which remains fixed." Most chemical formulæ are such genetic definitions. Failing substantial definitions, genetic definitions may be offered. (3) Conventional or technical definitions are those which give a fixed arbitrary meaning to a term in a context. Legal definitions are generally technical ones; for example, "a person" may be made to mean for purposes of the particular Act or Code, "Any

human being of either sex who has attained the age of majority and is of sound mind." A boy of fourteen is not a person at all by this definition. Such definitions, though very valuable in their own domain, are of little scientific value. (4) "Definition by type" consists in pointing out a typical example or individual of the class. Examples:- (1) That (by pointing) is a tree. (2) Food is bread, rice, etc. (3) The tiger is like a big cat. These are descriptions (because vague) rather than definitions and may have varying values. 'Ostensive' and 'extensive' are other names for definition by type. (5) An analytic or enumerative definition consists in enumerating all the qualities possessed by the thing defined. The details are so many and so peculiar that they cannot be summarised; for example, the lion can best be defined by such method.

(8) Examples

1. Tin is a metal lighter than gold.

[*Comments*: (1) Tin is not the only metal lighter than gold, hence, the definition is too wide. (2) Being lighter than gold is not the essential nature of tin. The actual properties of tin, as for instance, its atomic weight, specific gravity etc. should be stated].

2. The Sun is the star that shines by day [Circular definition, for day is that time when the sun shines.]

3. A lake is a sheet of water that has no outlet but is entirely surrounded by land on every side. [It is superfluous to add the words from, 'but' onwards. The earlier part is sufficient.]

4. A woman is a creature who cannot reason and who pokes the fire from the top. [Faulty almost in all respects: (1) 'creature' is far too wide a genus (2) 'cannot

reason ' is materially false (3) ' poking the fire etc. ' is mere accident].

5. Fishes are animals that live in water [Too wide].

6. Architecture is frozen music [Metaphorical].

7. A moral man is a man who does not lie or steal or live intemperately. [Negative, where it could have been positive.]

8. A leader is one who leads [Circular].

9. Kalidas is the author of the Shakuntala [Description. According to the view of some logicians, Kalidas, being a proper name, cannot be defined.]

10. The solar eclipse is that astronomical phenomenon which occurs when the moon comes between the sun and earth. [Genetic definition, to be allowed for want of a better one].

11. Vegetable means potatoes and the like [Definition by type; not illuminating].

12. A clock is an instrument that measures time [Correct; even the sun-dial is really a clock].

13. A foreigner is one who does not belong to one's own country. [Negative, yet quite sound].

14. A book is a source of learning. [Too wide and also too narrow. A teacher though a source of learning is not a book; and a book does not cease to be so even though it is not a source of learning but of amusement].

QUESTIONS ON CHAPTER I (B)

1. What is the purpose of Definition ?
2. How far is the distinction between Definition and Description logically sound ?
3. "Definitions are provisional and liable to revision." Explain.

4. What are the requisites of a logical Definition ?
5. Explain and criticise the doctrine of the Indefinables.
6. " Definitions are analytic, verbal propositions." Discuss this view.
7. Write notes on:—
   1. Definition per genus et differentia.
   2. Genetic Definition.
   3. Definition by Type.

(C) Division

(1) Definition of Division and its relation to Definition

Division is the mental analysis of the denotation of a rm. It is the splitting up of a genus into its species. he difference between Definition and Division is that hereas Definition analyses the connotation of a term ivision analyses the denotation. As denotation and onnotation are two aspects of a term, Division and Definion are two aspects of the study of the thing. Division elps the study of a thing by splitting up the whole sphere ito suitable sub-divisions. In order to make these subivisions, connotation must be known, so that variation f a particular quality may serve as the basis of Division. n the other hand, Definition must take the help of ivision, in order to be exact in its scope. Particularly e type of Definition known as Definition per genus et ifferentia presupposes Division. The differentia of some f the objects denoted by the term or the quantitative ariation of a particular quality in the objects is made the asis of Division and is called *fundamentum divisionis* or

the *principle of Division*. The term *divided must be* predicable of each one of the divisions. Just as the same term may be defined in various ways, so also it can be divided in various ways according as one or other principle of division is used; for example, books may be divided according to the nature of the subjects with which they are occupied, as books on Logic, on Mathematics, on Physics etc, or according to their *sizes*, as octavo, royal, demi, etc. (which is usually the printer's division of books); or according to the languages in which they are written, as Marathi, English, French, etc. So, men can be divided according to colour, or culture, or profession. The actual divisions can be ascertained only by material knowledge of the genus. More or less formal rules may be laid down by Logic.

(2) Rules of Logical Division.

RULE 1

Each act of division must be founded on one fundamental divisionis or *principle* of Division, that is, the subdivisions must be mutually *exclusive*. One and the same object should not belong to more than one head at a time. If it does, it becomes a *cross-division* or *overlapping divisions* (due to the employment of more than one principle). For example, division of men into civilised, red and Negroes involves three different principles, viz. culture, colour and race, with the result that the same man may be a Negro by *race, red in colour, and civilised*. Similarly, to divide metals into white, heavy and precious metals is to make overlapping divisions. Silver, for example, may find a place under all heads. The main purpose of division, which is to distinguish one class from another, is frustrated by a cross-division.

RULE II

The divisions must be *exhaustive*, that is, the sub-divisions must he together co-extensive with the genus divided. To leave some objects unaccounted for, or to add unwarranted classes, is either to confuse or mislead. As in the case of definition, so in Division, the fault may be committed in two ways. (1) If any class is omitted the division becomes *too narrow*. This fault is generally committed when only two divisions are hastily made where more are necessary. For examples, division of men into saints and sinners is too drastic, leaving no room for the vast majority of men who are neither saints nor sinners. So also, divisions, of books into logical and mathematical; climate into hot and cold, etc, are too narrow. (2) If an extra class is included, the division becomes *too wide*; for example, division of coins into gold, silver, bronze and bank-notes wrongly includes bank-notes which are not a sub-division of coins but of currency. As in Definition, so in Division, both faults may be committed at the same time, as in the above example, where not only 'bank-notes' are unwarrantably included, hut copper and other metals have been wrongly excluded.

RULE III

If the division is continued beyond one step, each step must be proximate, that is, at each step, classes must be co-ordinate or of equal status. This is achieved by making the act of division progress slowly, step by step. The rule is therefore sometimes expressed as "Division should not make a leap" ("Divisio non facit saltum"). If it does, objects are made to appear as on the same level though they are not so. For example, division of religions into Polytheism, Catholicism, Protestantism, Judaism etc. in one step

is division with a leap. Three steps are necessary and the divisions should be arranged as in a genealogical tree, in the following manner :—

- Religions
  - Polytheism
    - Hinduism, Budhism, etc.
  - Monotheism
    - Jndaism
    - Christianity
      - Protestantism
        - Presbyterianism ...
        - Religion of Dissenters, etc.
      - Catholicism
    - Islamism,
      - Shia
      - Sunni

(3) Divisions which are non-logical

A given class is to be divided logically, into its species. The genus is therefore always predicable of any one of the classes. The following ways of dividing are therefore unlogical..

(1) Physical partition of a thing into its constituent parts or members. For example, division of a table into legs, back and seat; of a book into its chapters, etc. A chapter is not a book.

(2) Mataphysical or conceptnl analysis of a complex thing into its different aspects. Such an analysis might be extremely useful for purposes of study but is not a logical process. For example, mind into knowing, feeling and willing faculties. The thing divided (mind) is not predicable

of any one of the faculties mentioned. It is not treated as a genus at all.

(4) Division by Dichotomy

In order to implicitly obey the two fundamental rules of division, viz, *exclusiveness* and *exhaustiveness* of the subdivisions, many logicians have adopted and recommended one peculiar method of division which is called "*Division by dichotomy.*" It consists in dividing the genus, at each step, into only *two* classes denoted by contradictory terms. Porphyry's tree (P. 6) is a wellknown example of divisions by dichotomy. Division by dichotomy has the merit of being always formally correct and as a preliminary to a genuine division. For instance, when some quality is known to be possessed by some objects under a class, the whole class may, to start with, be divided into two sub-classes, one, of objects possessing the quality, and the other, of the rest. For example, division of flowers into scented and not-scented led the way to manifold divisions later on. However, division by dichotomy need not be the only method. Particularly, such a division has the following defects:—

(1) Though it is claimed to be quite formal, it cannot be so, for some material knowledge is essential to determine the positive class. (2) The division makes it appear as if there are only two species under a genus. (3) Every time an 'indefinite' term is left, which is obscure. (4) At least one class is left in the end which may not exist at all. (5) Co-ordinate species appear as if they were subordinate and thus the division is misleading. (If division should not proceed by *leaps*, neither should it be *too slow* as division by dichotomy necessarily is). (6) The whole process is cumbrous. These defects may be illustrated by the following example:—

Triangles

Equilateral · Non-Equilateral

Isoceles Non-isoceles

[Right-angled Non-right-angled]

Scalene non-scalene

It is absnrd to divide Equilateral triangles into right-angled and non-right angled (because there cannot be any right-angled equilateral triangles); but formally who can gainsay snch a division ? Also, there is no such thing as a non-equilateral, non-isoceles and non-scalene triangle. The division makes it appear ns if there is.

However, if a genus is naturally divisible only into two classes, it does not on that account become division by dichotomy, for example,, division of lines ioto curved and straight (or non-curved) is not a division by dichotomy and does not suffer from the incidental defects.

(5) Examples

(1) Physicians into skilful, sociable, honest, negligent, native physicians and Doctor X [Too many principles of division used at a time with the result that there are cross-divisions].

2. A stone into colour, solidity, weight, extension. [This is conceptual analysis, and not a logical division. The term ' stooe ' is not predicable of any of these, though it can be studied from these varinus points of view].

3. Sequences of events into casnal aod causal. [Correct because exclusive and exhaustive.]

4. A person into hones, flesh, stomach, head and heart [This is " physical partition " and not a logical division. The terms ' hones ' etc. do not denote species, or sub-classes of persons, hut physical parts of one person].

5. Governments into democracy, oligarchy, monarchy and anarchy [Tno wide, anarchy heing nn species of government at all hut showing absence of any government].

6. Human beings into men, women and children. [Incnrrect, if sex is the fundamentum divisionis; correct, if wage-earning capacity is the principle. In " Time, Wnrk, Speed " *examples, it is customary to divide workers into* men, women and children].

7. The University into the Chancellor, the Syndicate, the Senate. [Physical Partition].

8. Students into graduates and non-graduates [This is n division by dichotomy, not much illuminating as ' non-graduates ' is a very indefinite term. However, formally correct].

9. Reasoning into deductive and inductive [Quite good, unless of course, ' mixed reasonings ' are thought of as a separate class of reasonings. Even though only two sub-divisions are made, it is not a division by dichotomy as there is nn negative term].

10. The Year intn Spring, Summer, Autumn and Winter [Physical partitinn and nnt a logical division].

QUESTIONS ON CHAPTER I (C)

1. State the meaning of Division and indicate the relation of Division tn Definitinn.
2. State and illustrate the Rules nf Logical Division.
3. Distinguish lngical Divisinn from (1) Physical partition and (2) Metaphysical or conceptual analysis. Illustrate ynur answer.

indication of exclusive and exhaustive classes, is the ideal aimed at by classification. Only, on account of the difficulties created by the diversity of actual things, classification falls short of Division.

(3) 'Natural' and 'Artificial' Classification

Classification is said to be of two kinds, Natural and Artificial. Natural (or General or Scientific) classification is one which is based on *all* the points of resemblance and difference and their gradation according to their importance, so that the divisions coincide *as if* with the grand Divisions of Nature. "In such a classification, there is a *large number of characters employed* even in higher divisions and a greater *definiteness* of characters as we descend lower in the series. Classification of mammals according to the character and arrangement of their teeth, that of animals in general, according to the structure of their limbs and the nervous system, and that of chemical elements, according to their atomic weight, would all be *natural* classifications, because in each case the quality which is the basis of classification is correlated with *many* other qualities.

A *natural* classification of animals is as under:—

- Animals
  - Vertebrate
    - Mammals
      - Monodelphic
      - Didelphic
    - Birds
    - Reptiles
    - Batrachia
    - Fishes
  - Invertebrate

and

A *natural* classification of plants is as under:—

- Plants
  - Cellular
  - Vascular (cotyledonous)
    - Monocotyledonous
    - Dicotyledonous, etc.

An *artificial* (or special or diagnostic) classification is one which is based on a few, often one, external but practically distinguishing, characteristic. The classification of candidates at an examination according to the alphabetical order of their surnames is an artificial classification; so also, the arrangement of words in a dictionary, or the Railway Companies' classification of animals for purposes of freight-charges. This distinction between *Natural* and *Artificial* classification can be made, if at all, in the case of animals and plants and minerals etc. because these are so to say produced by Nature. But in the case of things produced by man, all classification is bound to be artificial, because the things classified are themselves artificial. For example, stamps may be classified according to date (of issue) or value, or colour. Each one of these is as natural as any other. Similarly, if head-gears were to be classified, there is nothing to indicate whether the classification according to the power of protection from sun and shower would be more natural than others. Moreover, as artificial classification is based on some one resemblance, however superficial it may be, the resemblance is there already in the *nature* of the thing and in a sense, therefore, even such a classification would be natural. If candidates at an examination are classified artificially, as it is said, according to the alphabetical order of their surnames, one may ask

4. What is meant by Division by dichotomy? What are the merits and defects of such a division?
5. Write notes on (1) Cross-division (2) Division on facit saltum.

(D) Classification

(1) Definition of Classification

Cassification is a mental grouping of facts or phenomena in a series of divisions according to their resemblances and differences, so as best to facilitate the study of the subject. It is important to remember that classification is a mental process. The actual physical arrangement of things, as in a museum, depends on the mental grouping which follows a particular line of division. Classification is a very early process in the development of knowledge. To know things is to read orderliness in them; and in the first instance, this is induced by noting the similarities between things, in other words, by classifying them. Even lower animals have a faculty of classifying. Among men, the process becomes more explicit and conscious. To name a thing is to classify it, to place it under a class. Classification, as a scientific process, is only a more advanced step in introducing orderliness.

(2) Relation between Classification and Division

So far as the *results* are concerned, Classification and Division are mainly the same, namely, a scheme of interrelated classes. But the results are reached in *different* ways and consequently are slightly different.

The following differences between the two processes may be noted:—(1) The starting point, in Classification,

is individual objects or events and the result is a class or wider classes; the starting point, in Division, is a class and the result is its lower and lower species. This difference is often expressed by saying that Classification goes upward, whereas, Division goes downward or that classification is an inductive process, and division a deductive process. In some subjects where definitions are fixed, as in mathematics it is simpler to proceed by Division, in others (those depending on actual experience) it is necessary to proceed by classification. (2) Classification is generally a *series* of divisions, and therefore a process which is far more elaborate than Division. (3) In classification, the hard and fast rules of Division have to be loosened. For instance, the classes may not be mutually exclusive or exhaustive. Things come into observation which fit in in more than one class and have therefore to be thought under all these heads. For instance, in classifying books one will have to assign 'prose' section, as well as 'politics' section, to Burke's "Reflections on the French Revolution." Moreover, room for any new class of things has always to be reserved. A '*new*' thing may come into existence, or having been in existence might become known. Hence a class called 'miscellaneous' is almost a necessity. For instance, it is difficult to classify a book which contains information on many subjects. It cannot very well be placed under 'Reference'. The only way is to relegate it to a 'Miscellaneous' class. It is for this reason that Jevons calls classification a tentative process. The sponge long thought of as a vegetable is now thought as an animal; and what is the cock, bird or beast? (4) The scope of classsification is unlimited as it applies itself to inexhaustible Reality; the scope of Division is professedly limited, as it applies itself to a given, definite genus. However, Division, with its

whether the surnames are *not after all* a part of the *nature* of the candidates. Sometimes, an artificial classification serves the purpose of science better than a natural classification. So it happened in the case of the famous Linnean classification of flowering plants, according to the number of stamens and pistils possessed by them. It was begun as a purely artificial classification, but that itself became established as a natural classification as it was discovered that the number of stamens and pistils though an extraneous test, is connected with many other and vital functions. Similarly, the classification of mammals according to their teeth has to be called *natural rather than artificial*. In fact, the distinction between natural and artificial classification is not absolute. It is a distinction of purpose. Classification with a practical purpose is artificial, that with a theoretical purpose is natural. Even an artificial classification serves many useful purposes. In the first place, it makes identification of a class easy (and such an identification is *the chief aim of classification for purposes of knowledge*); and in the second place, it often *leads* to a natural classification. It is very useful to start with. Though it may be discarded afterwards, it has served its purpose by suggesting the more natural classification.

(4) Rules for "Natural" or Scientific Classification

RULE I

There should be a large *number* of common characters possessed by one class and a large number of differences from another class. This is the principle of the 'coincidence' of characters. Supposing the letters to indicate characters, the four things, abcd, rst, pst, abce, should be classified thus:—(abcd, abce) (rst, pst). They are shown under *two* classes on account of *many common* characteristics.

RULE II

Classes should be distinguished by the *importance* of characters. This is the principle of the *subordination* of characters. Given *ab, bc, ac,* they should be arranged as (*ab, ac,*) *bc*, for though the pairs, *ab, ac;* and *ac, bc* have one common character, *a* being the more important, *ac* should be classed with *ab* rather than with *bc*. Various means have been suggested to determine the importance of characters. Mill mentions (1) Likeness to others (2) Individuality and (3) Attractiveness as the marks of importance. Dr. Fowler objects to attractiveness as a mark of importance as it makes an artificial classification. He suggests, as tests of importance, (1) the power of being an index to many other characters and (2) the accompaniment of other characters. Prof. Mellone calls those important which are (1) essential and (2) have most determining influence on others; for example, structure of teeth or kind of food, in the case of animals.

RULE III

The classification should be *gradual*, that is, a large number of divisions should be employed. There should be no leap. For instance, abc, pst, st, abcd, rst, abce, should be tabulated in two steps as under:—

abc
abcd abce

st
pst rst

RULE IV

The arrangement should be in a *natural* series, that is to say, the distance between the classes should be an indi-

animal world, the nomenclature used is this Kingdom, Sub-Kingdom, Genus, Class, Tribe, Family, Species, Variety, etc. In Chemistry, the differences are well expressed by the ending expressions as in sulphate, sulphite, sulphide, sulfuric, etc. Good Nomenclature and Terminology ought to be made up of expressions which are *brief*, *significant* and *definite* in meaning. Once an expression is incorporated in the Nomenclature or Terminology of a science, it must always be used in the fixed *technical* meaning and its older associations must be snapped; otherwise confusion in thought would be created. For example, in the domain of colour, 'parrot-green', 'orange-yellow', 'sky-blue', 'snuff-coloured', indicate definite colours, even though parrots and oranges might have infinitely varying shades of colour among themselves.

QUESTIONS ON CHAPTER I (D)

1. Define Classification. Compare and Contrast Classification and Division.
2. Explain the distinction between a Natural and an Artificial classification and say whether it is absolute.
3. State and illustrate the Rules of Natural Classification.
4. What help does Classification give to thought? Has Artificial Classification any use?
5. Briefly state the views about the basis of the process of Classification.
6. How has evolutiory theory affected Classification?
7. What is the use of a developed Nomenclature and Terminology?

CHAPTER II

The General Nature of Induction

(1) Definition of Induction

Inductive Inference, or Induction, is the process of ascertaining universal propositions, causal connections or Laws of Nature, from facts of observation. It is to '*induce*' order in the facts observed. To deduce is merely to unfold the implication of a given proposition or a set of propositions, to apply a general proposition to a particular case or cases. But general propositions are in the last resort obtained as inferences or generalisations from observations. Thus Induction must precede Deduction in the actual acquisition of knowledge. But Induction is not the only way of furnishing the mind with general propositions; for Intuition may furnish some. The transition from general propositions to their particular applications, that is to say, deduction, is certainly easier than the transition from observed events to trustworthy generalisations, which means Induction. The difference between Induction and Deduction, therefore, is on both counts, namely, in the starting point and the conclusion. The starting-point, in an Inductive inference, must always be particular facts of observation, and the conclusion must always be a *general* truth of some type or

cation of difference. The more the distance, the more the difference. This is called the principle of *affinity*. Given a, ab, b, a'b, a'b', they should be arranged as a, ab, a'b, a'b', b, wherein the difference is shown by the distance. This rule is very difficult to apply, owing to the *complexity* of characters. Hence there often arises the necessity of '*bracketing*'. If two candidates at an examination get an equal number of marks, and a third one less, the first two are both to be called *first* by being bracketed; yet the third remains third and does not become second. So also, some characters may have equal affinities to more than one class. Such things should either be placed under more than one head, or under a class called 'miscellaneous' The sponge, for instance, was seen to have equal affinities with the vegetable and the animal kingdoms. It was long afterwards that it could be definitely classed as an animal.

(5) The Importance of Classification

Classification, though a very early process in the understanding of things, is very helpful. (1) It facilitates the work of memory. Things to be studied form such a labyrinth at first sight that unless they are thought of under different heads, no progress can be made in the study. (2) It enables the greatest number of *general* assertions to be made about the class, that is it helps the process of Induction. (3) It enables us to infer of any other member, a great part of what we know about any member of a class, by means of Analogy.

(6) Views about the Basis of Classification

There has been some dispute as to the way in which classification is actually brought about. (1) According to one view, classification is based on *definition*, that is, on

the knowledge of the *qualities* possessed by the things. (2) According to another view, it proceeds by taking one typical individual and arranging others round about it according to their resemblance to it. This is called classification by Type. The first view seems to be the correct one, as the resemblance between things must be determined by our knowledge of their attributes. (3) Classification by series means a classification in which the classes are grouped in a graded system in the order of importance.

(7) Effect of Evolution-Theory on Classification

The evolution-theory of Charles Darwin has given a new meaning to the work of Classification. The rules are made to apply with reference to the *origin* of species. (1) 'Affinity' gets the definite meaning of family-relation. (2) The importance of attributes is judged by the *community* of origin; for example, man and monkey are brought together. (3) Classification becomes a process showing the growth of different species from a common ancestral stock. It becomes, therefore, a deductive process. (4) The distinction of 'Kinds' in Nature vanishes. Differences are due to environment. However, recently, great doubt is being cast on the evolution-theory itself.

(8) Nomenclature and Terminology

The work of classification, division, etc. would be well nigh impossible if there is no aid of brief, technical words, as things and their parts are extremely various. The system of *names* for the *classes* with which the science is concerned is called Nomenclature; and the system of expressions, including names, verbs, adjectives, prefixes, suffixes, etc. for the parts, qualities or processes of the individual objects included in the classes, is called Terminology. For example, in the

other; in short, there must always be a '*leap*' in an inductive inference (which is generally prompted by sagacity). The waters of inductive inference must rise above their source. However, it is not to be supposed for a moment that Deduction and Induction are opposed to each other. Scientific investigation has to resort to both the types of inference. Hardly can any new law be discovered without the combination of both Induction and Deduction. Logically, however, as noted above, they are two distinct modes of inference.

(2) Consideration of some other Definitions of Induction

Induction has been defined in various other ways:—

(i) "An inference from the particular to the general." This definition is vague as it does not state what the particulars must be and what the general is. The particulars are not particulars in the sense of strange things, but in the sense of individual things. The general really means a statement having some sort of generality (regularity, uniformity, etc). (ii) Induction has been defined as "inference from the known to the unknown or from the past to the future". Now, this would be a misleading definition because (1) if the 'unknown' or 'future' cases are strictly unknown, we could not apply to them the results of our investigation of the 'present' or 'known' cases. The improvement suggested, namely, from the known to the comparatively unknown does, not remove the absurdity. (2) The reference to time is also misleading. An inductive inference need not necessarily refer to the future. It is not the time-element, but the nature of inference that makes it inductive; for example, if the causes of the French Revolution are discovered by the Inductive method, they would

(3) What 'Scientific' Induction is Not

'Scientific' Induction must however be carefully distinguished from similar processes which, though called Inductive on account of some common element or another with Induction proper, do not amount to it.

Four such processes may be mentioned:—

1. Perfect Induction or Induction by Complete Enumeration.
2. Imperfect Induction or Induction by Simple Enumeration (Inductio per enumerationem simplicem).
3. Colligation of Facts.
4. Parity of Reasoning.

(4) Perfect Induction or Induction by Complete Enumeration.

Perfect Induction or Induction by Complete enumeration consists in collecting particular statements and expressing them in the form of a collective universal proposition. For example, having seen each month of the year to possess less than 32 days, to summarise the observations as "All the months of the year have less than 32 days", is to make a "Perfect" induction. Similarly, having seen each and every book in a cupboard in a library to be a book on Logic, to generalise by saying "that all the books in that cupbord are logic-books", or having separately seen the different countries of Europe to possess a standing army each, to put forward the proposition, "All the countries of Europe possess standing armies" is a case of Perfect Induction. Now such "Perfect" Inductions are not scientific Inductions, because there is no *novelty* at all in the so-called conclusion; there is not that proverbial 'leap' required to make it an inductive inference, with the result that the conclusion though universal in appearance is not a scientific

universal but merely an enumerative one. It does not possess the value of a scientific generalisation. Not that "Perfect Induction" is altogether useless. It serves as an excellent shorthand summary of many statements. The knowledge of a general law spares us the need of worrying over each particular case. Perfect Induction is very useful as an aid to memory and for purposes of easy reference. In the words of Jevons, "Perfect Induction is absolutely necessary to enable us to deal with a great number of particular facts in a very brief space." But, for all this value, Perfect Induction is not scientific. It takes rounds and progresses not. It is far too tame an affair to become a real or scientific generalisation (which must involve a "leap").

(5) Imperfect Induction

Imperfect Induction or Induction by Simple Enumeration consists in inferring a general, that is to say, a *universal* proposition, from a number of positive observations. It rests on uncontradicted experience. For instance, seeing that all observed crows ars black, to say 'All crows are black' is to practise imperfect Induction. This is called 'imperfect' as contrasted with 'Perfect;' because all the individuals are not observed. This 'Imperfect Induction' again is not a scientific induction because though it contains the inductive 'leap', the leap is not *scientifically* achieved. It is too big a leap. There is no *certainty* about the conclusion; for even a single negative instance is sufficient to overthrow the conclusion. In Prof. Mellone's words, "No, mere counting of instances however many they may be, can make a conclusion more certain. A mere assemblage of positive instances is simply worthless". Most of our superstitious beliefs are nothing better than such imperfect

Inductions. That comets forebode evil; that thirteen at a table spell disaster; that an enterprise is frustrated if the adventurer is crossed by a cat or a widow, are all imperfect Inductions based on a few observed cases. Once they have gained root, none dare to test their truth as that would be like "tasting poison." So they gain ground on the strength of being uncontradicted by experience. But this does not mean that every imperfect Induction is bound to fail in fact. On the contrary, many times the imperfect Induction itself becomes a scientific Induction. At any rate, it has the great value of suggesting a hypothesis. Generally, it is not without some reason that so many observations point in the same direction. Imperfect Induction furnishes a strong presumption or probability, if the number of instances observed is very great and there is reason to believe that if there were any instances to the contrary, they would have become known to us. The conclusions reached by imperfect Induction are mere empirical generalisations. Though not scientifically beyond doubt, they are of much practical use in life. The old farmer who has always had the experience that whenever ants are seen moving about rain follows, *profits* by the "imperfect" Induction, though unable to establish causal connection.

(6) Colligation of Facts

By "Colligation of facts" is meant the summing up of many observed phenomena under a formula which would comprise them all. For instance, if very many positions of a planet are marked and, it is seen that an ellipse would be formed if these positions are connected with one another then to conclude that the planet moves in an ellipse is a "colligation" of facts. Similarly, on sailing along the coast of a piece of land, if one reaches the starting place again, to

conclude that that piece of land is an island is to colligate the experience. And if a child's height as it grows is marked on a wall from year to year, for many years, the graph that will show the ratio of the child's age to the height would be a sort of colligation. Such colligation of facts is not to be ranked with scientific Induction for the simple reason that there is no inference or reasoning as such in it. It is only a wider or more general *observation*. It is a complex notion formed out of simpler notions. That is all. According to Dr. Whewell, Induction is the same as colligation; but Mill opposed this view for reasons above stated. Induction, he pointed out, is much more than mere colligation, though colligation may serve as "a necessary preparation to Induction." Colligation is distinguished from Perfect Induction in as much as it is not based on an exhaustive search. Gaps are left and made up by sagacity, with the consequence that the conclusion of colligation is not a mere summary as in the case of Perfect Induction. Colligation is distinguished from Imperfect Induction in as much as, in it stress is not laid on the *number* of instances observed, but on the *binding force* of a few instances.

(7) "Parity of Reasoning"

"Parity of reasoning" consists in extending the proof for a particular statement in a given case, to *all* cases of the same type. For instance, because in a given triangle ABC, the three angles are together equal to two right angles, to argue that therefore in all triangles the angles are equal to two right angles is a case of Parity of Reasoning. The general conclusion thus reached, however, is not an inductive inference. It is the repetition of a previous inference and not a new inference at all. The general proposition is not based on the *observation* of the particular triangle, but on the proof already given for that triangle. The argument

is not from an observed fact but from a given resemblance. The basis of Induction, namely, a fact or facts of observation, is absent. Parity of Reasoning, therefore, even though it may conclude a *general* proposition from a *particular* case is not Induction as it lacks the required data of observation. The inference, if any, involved in ' Parity, ' is deductive, not inductive.

(8) Certainty of Inductive Inference

As Inductive Inference means generalisation from one or a few observations, its validity is easily questioned. For it is asked how we can apply a generalisation from observed facts to those that are beyond present experience. So long, our ancestors and we have witnessed the sunrise every day; but what absolute guarantee is there that it will rise to-morrow? Such a line of objection-raising can be met only by admitting it and confessing that inductive inference must, in a sense, always remain uncertain. But it should be made clear at the same time, that in the same sense deductive inference also is uncertain. The uncertainty belonging to both types is, in the last resort, the uncertainty that inevitably attends everything mortal. But if the analysis of a given phenomenon is exact, there is no reason why a generalisation based on such an analysis should be uncertain. It is imperfect Induction that remains uncertain because it lays stress on the number, rather than on the nature, of the instances observed. But scientific induction, proceeding on accurate analysis of the *nature* of the phenomenon, will be as certain as any other humanly drawn conclusion. For instance, if a piece of copper is dipped in vinegar and kept in it for some time, it is seen to turn green in colour. A generalisation, from even one such observation, that vinegar turns copper green will go unchallenged. Similarly, if poison being admini-

stered to a dog, the dog dies soon afterwards, that poison kills animals can be inferred with complete certainty. If one were to say that only that poison killed that dog were the only thing known, then inference is at an end. A generalisation simply because it is based on particulars need not partake of the particularity and uncertainty belonging to each event separately. Inductive Inference is to be credited with certainty on the strength of its underlying grounds or presuppositions.

QUESTIONS ON CHAPTER II

1. Describe the essentials of Inductive inference. State and criticise a few suggested definitions.
2. Distinguish scientific Induction from
   - (1) " Perfect Induction "
   - (2) " Imperfect Induction "
   - (3) " Colligation of facts " and
   - (4) " Parity of Reasoning "
3. Is Inductive inference necessarily uncertain ?

CHAPTER III

THE PRESUPPOSITIONS OF INDUCTION

(1) The Law of Universal Causation

How can we *generalise* legitimately from one or a few observed facts? We can do so on the assumption that Nature is orderly, and not chaotic. This assumption is generally expressed in two ways:— (1) The Law of Universal Causation and (2) The Law of Uniformity of Nature.

The Law of Universal Causation means that everything that happens is caused by a set of conditions from which it necessarily follows, that is to say, there is no such thing as a pure accident in the sense of an uncaused event. The cause of a thing may be unknown but it must have a cause. Events happen that are unexpected or unforeseen but not uncaused or undetermined.

(2) The Law of Uniformity of Nature

The Law of Uniformity of Nature means that there is a reign of law in Nature, that Nature acts in uniform ways, that the same cause must have the same effect. It does not mean the maintenance of the present order of things in the Universe. Uniformity of Nature is something quite different

ı the uniform course of Nature. In this latter sense, e is no strict uniformity at all, because Nature is ıging; and the future, as Green points out, might be edingly unlike the past. The Law of Uniformity does at all imply the denial of variety in Nature. This is admitted even by Mill (who defines the principle of formity as " the future will resemble the past ") when ays, " The course of Nature is not only uniform; it is infinitely various. " What is really meant by Uniformity of Nature is not absence of variety but that so far as the e conditions may recur, the same consequences follow.

(3) Oneness of the Two Principles

In this way, the Law of Uniformity is implied in the v of Causation. The Uniformity is really Uniformity of ısation. From another point of view, the principle of iformity is a wider principle of which the principle of ısation is a special application. The principle of iformity covers *all* laws whether they are causal or not. instance, Empirical laws or Laws of Co-existence are iformities which are not causal. All laws of sequence are laws of consequence. Mill himself divides Uniformities o two kinds (1) Uniformities of co-existence and) Uniformities of causation. Moreover, the element of e enters into the causal relation but not into a law. iformity means reign of law; causation means law of ınection *in time*. But really the two Laws are two expresns of *one and the same principle* that Nature is a tem of relations (causal or non-causal).

(4) Uniformity different from Unity

The law of Uniformity of Nature is sometimes expressed the Law of *Unity of Nature.* This expression far from

being an improvement is worse than the original, for it indicates a particular philosophical theory which is not unquestioned. As there is no reason to commit oneself to a monistic theory of the world, in order, to maintain its uniformity, it is better to avoid the expressioo, " Unity of Nature. "

(5) Plurality of Causes aod Intermlxture of Effects

On the strength of the doctrine of ' *Plurality of Causes* " nnd ' *Plurality (or intermixture) of Effects*', it is sometimes thought that we could have universal '*Causation without Uniformity* of sequence. The doctrine of " Plurality of causes " means that every event, though it must have a cause, need not have the same cause every time, but may have Plurality of causes. For instance, death, it is said, may be due to different alternativo causes like poisoning, drowning, heart-trouble, etc. *Similarly*, the doctrine of " Plurality of Effects " means that one and the same causo oced not produce the same effect every time but may produce diverse effects on *different occasions. For instance*, a lighted match will produce ao explosion if brought into contact with guopowder, will hurn haystack, but will be extinguished if thrown into water. Now these doctrines are only superficially true. There cannot really be different causes for the same thing aod different effects following the same cause. What appear to be *different causes are not* causes for really the same kind of event. It is not the same death that is due to different causes. Similarly, what appear to be diverse effects are oot *really of the same cause*. The cause of explosion, burning and cooling dowo (above referred to) is not really the same namely the lighted match; the cause contains *different factors* each time in addition to the match. If events changed their causes and their effects,

it would be useless to look for causal connections. If the same food nourished me one day, made me sick another day, and killed me on a third, it could not be the cause of any of these things. We cannot say that one event is the cause or effect of another unless they are so connected that the one *always* follows the other and the other is *always* preceded by the one. This means that the Law of Universal causation necessarily implies Uniformity of sequence.

If, however, by Plurality of causes is meant composition or the presence of a large number of conditions, that is to say, Plurality *in* cause; and by the Plurality of Effects that the effect is a complex or intermixture, then it is true, for the cause is really the totality of conditions, though the last of these is generally called the cause. The last condition has a great practical importance, but scientifically, cause is the totality of the conditions, and in this sense the relation between cause and effect is strictly a reciprocal relation, that is to say, one and the same thing has one and the same cause and one cause produces one and the same effect. There is no Plurality *of* cause though there may be Plurality *in* cause. In practical life, however, we take cause or effect in a loose way and assume a plurality of causes. For instance, a householder thinks of diverse causes of getting his house rid of rats, trapping, poisoning, etc. being the alternative causes. What is popularly given as the cause is either more or less than the scientific cause and hence the apparent Plurality of causes. The hypothetical proposition, "If A is B, C is D" has therefore been interpreted (because so used in practical life) so as to say that A being B is one of the plural number of causes of C being D, that it is not *the* cause, so that affirming the consequent does not necessitate the affirming of

the antecedent. Scientifically, however, there cannot be universal causation without uniformity of sequence.

(6) Can these Principles be proved?

Now these two laws (Law of Causation and Law of Uniformity) are *presuppositions* or assumptions of Induction; for without a conviction that the events that happen are connected in certain ways, neither the work of science nor that of ordinary life could be carried on. They cannot be "proved," because there is nothing more certain from which they could be derived. But they need not be proved. Ultimate truths do not need any proof, nor are capable of any direct proof. A negative proof, however, may be given, namely that if these principles are not true, there is no truth or certainty left in the world; if they are taken away, nothing will stand. According to Mill and Fowler, these laws are themselves derived by Induction from experience. This is not possible. In the first place, such a procedure would involve a petitio principii or argument in a circle; for unless they are true Induction is not possible. Dr. Fowler tries to meet this objection by means of an appeal to wider experience; but, experience itself cannot be had unless things are, logically, assumed to have orderly connections. As in the case of the Laws of Thought, a clear formulation of the Law of Causation and of Uniformity of Nature may be a later growth; but logically, as experience depends on them, they could not depend on experience. Secondly, even if they are inductions, they would be inductions of the weakest type, namely, inductions by simple enumeration and therefore uncertain. Moreover, experience does not actually support the Laws. Actual experience very often shows contradiction rather than uniformity. We believe in uni-

formity not on account of actual experience but in spite of it. Particular *Laws* of Causation are no doubt, to be discovered by experience, but this does not affect the initial assumption of the *Law* of Causation. The Laws are, therefore, independent of expereince. Nor are they self-evident in the sense of being palpably present in our consciousness. Thought is about things and unless these are assumed to be connected in some orderly way, no thinking about them is possible. To think is to read order and system in the things thought about. To deny the Law of Causation and the Law of Uniformity of Nature would be to deny the possibility of knowledge itself. Hence, they are the presuppositions or assumptions of Inductive inference and make that inference valid.

QUESTIONS ON CHAPTER III

1. Explain the meaning of "Uniformity of Nature" and "Universal Causation." Can these principles be proved?

2. Discuss the doctrine of the "Plurality of Causes."

CHAPTER IV

THE MEANING OF CAUSE

(1) Scientific Cause distinguished from Philosophic and Popular

As every event, it is presupposed, must have a cause and the same cause, to discover a causal connection is the same as to establish a Law of Nature, which has to be certain and unchanging. It is therefore necessary to determine what is meant by ' cause ' in science.

The scientific meaning of cause must be very carefully distinguished from the philosophical and the popular one. Cause, in the philosophical sense, is the *ultimate* reason for the happening of a thing or event. And Philosophy might very well say that all things and events are ultimately one, as being traceable to one and the same eternal cause. But science does not want to probe into the ultimate nature and cause of things. It wants to know the *proximate* or immediate cause and not the ultimate one. So also, the final or *teleological end* of events might be considered as their cause philosophically, but not scientifically. It is mechanical, as against teleological, cause with which science is occupied.

Again, cause as required for science must be distinguished from cause in the popular sense. In the popular

(3) Definition of Scientific Cause

Cause, for science, of a given event, may, therefore, be defined as the group (or *sum-total*) of its *immediate, invariable, unconditional, relevant, antecedents.* These characteristics may be made clearer. In the first place, cause, for science, is always of a *given event.* Science does not want to know the cause of the whole universe as one product, but looks upon the world as made up of a number of discrete events for each of which there is a cause which is to be discovered. Secondly, *for scientific purposes, the cause must be antecedent in time* to the effect. This means that the time-element necessarily enters into the causal relation. But it does not mean, as in popular mind it very often does, that time itself is the cause of things. For instance, it is thought that time is the cause of milk changing into curds; it is the cause of the growth of a seed into a plant or of gunpowder making an explosion, or of paint drying up. Time is not however, the cause of any of the above changes. The causes are different,

When it is said that some time must elapse between the cause and the effect, it is not to be supposed that there is such a thing as vacant time. All that it means is that cause must be considered as prior to the effect in time, that theoretically, the curtain of time stands between cause and effect. The actual world is a process, but for scientific study, the process has to be thought of as made up of discontinuous, discrete events, and the cause has to be identified with the antecedent part. Only a mathematical line, therefore, divides the cause and effect. When a continuous reality is split up into parts, the earlier parts are considered to be the cause of the later ones. The separation of the continuous process into cause and effect is guided.

hy the nature of the process. The causal connection is a sequence *in time*, and, in this sense, time enters into the causal connection. It is not a part of the cause itself. Thirdly, the cause must be an *invariable* antecedent. This does not mean that it must be repeated; for an event as well as its cause might be so unique that it is impossible that they should be repeated. For instance, the cause of the French Revolution even though it happened once was its invariable antecedent in the sense of being indispensable. Fourthly, the cause must be an *unconditional* or *independent* antecedent. Mere invariability is not a sure sign of the causal connection because the so-called cause might be a co-effect (along with the so-called effect). The night invariably follows the day, yet the day is not its cause, both being caused by the revolution of the Earth round the sun. Similarly, though thunder follows lightning, they both are produced by the pressure of clouds. Fifthly, the cause must be the *immediate* antecedent. This means, as already indicated, that science does not want to go back to the ultimate origin of things The proximity, however, has to be decided in each case relatively to the nature of the phenomenon and the purpose in view. No fixed standard of duration of time is applicable. The 'immediate' cause of a big event like the French Revolution is not so immediate as the cause of boiling of water in a kettle. Sixthly, the cause is the *collection*, or rather combination, of all the necessary conditions, and not merely the last one (which is the occasion) out of them This means that even negative conditions will have to be comprised in the cause. By a negative condition of any result is meant the absence of whatever may thwart the appearance of the result. For instance, the absence of storm is a negative condition, and therefore a part of the cause, of the speedy arrival of a

ship ; and absence of damp weather of the explosion of gunpowder. Lastly, the cause must include only the *relevant* conditions, a host of other conditions being taken as inert. Time, Space, Gravitation are present everywhere, but in stating the totality of conditions, they need not be mentioned. If relevancy is not taken into consideration, even for the slightest happening, there will have to be an endless number of conditions. All the above points are to be understood even in the simplest definition of 'cause'. The definition suggested by Prof. Wolf may be accepted on account of its simplicity. "By the cause of an event or result is meant the minimum totality of conditions each of which is indispensable and all of which are together just sufficient to bring about that result." (Text-book of Logic P. 284). From the point of view of quantity, cause and effect are said to be equal, that is to say, proportionate to one another. To stress this point, Prof. Carveth Read writes, (P. 183) "The cause of any event, when exactly ascertainable, has *five* marks. It is quantitatively *equal* to the effect, and (qualitatively), the *immediate, unconditional, invariable, antecedent* of the effect."

(4) Cause distinguished from Reason, Symptom and Condition

It will be seen, from the foregoing discussion, that *Cause* is different from reason, symptom and condition.

Reason is not cause in the scientific sense, but the ultimate ground or the philosophical notion of end. The reason for an event need not be in the material world, but may be a purpose in a mind. For science, however, reasons of such kind are irrelevant.

The cause is also different from a symptom or sign.

The latter is not invariable and may not be antecedent being very often an accompaniment or even the effect of the event. Thus, thirstiness is a sign of fever, but not its cause, fever being in fact the cause of thirstiness. Similarly, the ringing of the bell is a sign for the teacher to go to the class; it does not make him go to the class.

The cause is likewise to be distinguished from a condition. A condition (or disposition or tendency) is indispensable to the effect, yet not sufficient to produce the effect. It is merely a part of the cause. A number of conditions together make up the cause. Most results are complex, and need the fulfilment of a number of conditions each of which is indispensable but is not adequate by itself to complete the result. Thus, water is a condition, but not the cause, of a person being drowned.

QUESTIONS ON CHAPTER IV

1. Distinguish scientific cause from the philosophical and the practical.

2. Give a full definition of cause in science and explain the terms used in the definition.

3. State and illustrate the difference between Cause and (1) Reason (2) Symptom (3) Condition

CHAPTER V

OBSERVATION AND EXPERIMENT

(1) Definition, Nature and Importance of Observation and Experiment

If the principles of Uniformiy of Nature aod Uoiversal Causation are tbe formal grouods of Induction, observation and experiment are the material grounds. They supply tbe data for infereoce. Scieotific observation may be defioed as "watching with attentioo phenomena as tbey occur" and experimeot may he defined as "observation under pre-arraoged aod controlled conditions." Observation is not so easy as it appears to be; very often observations are partial, superficial and fragmentay. Such observations are useless. Observation is not merely seeing or looking at things. As Prof. Minto remarks, "We may stare at facts every minute of our waking day without being a whit the wiser." The thing that viciates observation most is its mixture with interpretation or inference. This is not usually noticed, because the interpretation is so rapid and spontaneous that the sense elements and the interpretations coalesce into one experience the whole of which appears to he given immediately. That is why there are conflicting descriptions of the same objects or events, as frequently happens in the Law courts A pure observatioo is the rarest thing in the world. When one says, looking out of

the window, that one sees a tree, what one sees is generally not the whole tree, but its top-most branches, from seeing which "the tree" is "constructed." How easily, not only children but grown-ups, are deceived in observation is attested to by the magical tricks. The story of Raleigh's tearing to pieces his manuscript of the "History of the World" on seeing that two persons could not agree in their observations about an ordinary incident, impresses the difficulties in correct observation. If a person is run over by a vehicle at a time when two vehicles are going, the onlookers will generally vouchsafe to the fact that the person was run over by the bigger, though as a matter of fact the smaller vehicle might be responsible for the accident. In short, observation is not merely a physiological process, but is a mental one; nor is the observer merely a passive recipient of impressions. Had it been so, there would be no difference between a living observer and a mirror or a photographic plate. Observation is always selective and purposive and is guided by interest. That is why one sees in an incident what another does not. "The personal equation" plays a very prominent part in observation and has to be discounted in making use of the observation. Prof. Mellone remarks, "Millions of events that pass before a man never enter into his experience at all; they have no interest for him, and hence he does not notice them..... In science, this interest springs from previous knowledge." Experiment is even more difficult than observation as the conditions are to be of our own making or artificial arrangement. Though it is not possible to draw a hard and fast line between observation and experiment, some *interference* or tampering with the obeject under observation distinguishes experiment from observation. Thus dissection is a case of observation; but

vivisection is an experiment. Observation by means of instruments marks the transition between the two. Experiments are not possible in certain departments of study as Astronomy, Geology, Meteorology etc. In certain others, as in Sociology, Psychology, Biology etc. (that is in sciences concerning man) they are not allowed, even if possible, beyond certain limits, as human life is too precious to be tampered with by experiments. In Physics, Chemistry, etc, they are practised on the largest scale. Generally, observation is more useful in investigating the cause when the effect has been given, and experiment more useful in discovering the effect when the cause has been given.

(2) Advantages of Experiment over Observation

Obviously, experiment has decided advantages over observation. Dr. Fowler observes, regarding the superiority of experiment to observation, " The experiments which we may conduct in an hour are often worth a century spent in observation ". This is so for the following reasons:—

(1) In experiment, *repetition* is always at our command and so we have not to wait on the whims of Nature. (2) A larger *variation* of attendant circumstances is possible in experiment. In observation, we are pinned down to a limited number of circumstances. New circumstances cannot be introduced. (3) The *precision* is decidedly greater in experiment than in observation, due very often to exact quantitative measurements. In observation we have to make haste. (for instance, in the observation of a rainbow in the sky) and the phenomenon may not last long enough to allow of exact measurements. (4) Like variation of circumstances, *isolation* or elimination of circumstances can be done in experiment. (5) So also, *invention* of circumstances can be made; for

instance, vacuum (though Nature abhors it !) can be made in experiment. Briefly, the disadvantages of observation as compared to experiment are due to the complexity, rarity, swiftness or slowness of events as they occur in Nature by themselves. However, Nature herself from time to time produces unusual phenomena, as in the total eclipse of the Sun. Such events are called " *Natural Experiments* " as if they are experiments made by Nature.

A " *Blind* " or " *Negative* " experiment is one in which the suspected cause is eliminated in order to show that the effect also is absent and thus to prove the reciprocal relation A negative experiment is far more difficult than a positive one, for the effect might be still present and yet too minute for detection. Thus, though the constitution of the atmosphere was determined by many experiments, argon escaped notice for a considerable time, and was only recently detected. Similarly, when, from finding organisms developed, even though germs were excluded from the water, the hay, and the oxygen, in a hermetically sealed bottle after it was plunged upside down into a basin of mercury, Pouchet concluded that life had been 'spontaneously' generated, Pasteur showed that Pouchet's error lay in not suspecting the mercury which really carried the germs into the vessel.

"A *crucial* experiment (experimentum crucis) or *crucial* instance (instantia crucis) is an experiment or observation which enables us at once to decide (like a finger-post) between two or more rival suggestions or hypotheses. For instance, both the corpuscular theory and the undulatory theory,of Light, seemed equally plausible, till " a crucial experiment " decided the issue in favour of the undulatory theory. It was first proved by mathematical calculation that if the corpuscular theory were true, the velocity of

Light would be greater in water than in air, and that if the undulatory theory were true, the velocity of Light would be greater in air than in water. Experiment (by means of a highly ingenious apparatus for ascertaining the velocity of Light) proved that as a matter of fact the velocity of light is greater in air than in water. This was the "crucial experiment".

(3) Rules for Observation and Experiment

Good observations and experiments largely depend upon personal skill and practice. Logic can only suggest general hints. Prof. Joseph writes, in this connection, " Scientific observers have to be trained to be accurate in distinguishing, alert in noticeing, quick in selecting, and intelligent in interpreting ". In other words, the following qualities must be possessed by a good observer (or experimenter) (i) The observer must possess impartiality and modesty. If the observer is partial, he will not arrive at truth. He must also be humble and *seek* the truth wherever he finds it. Facts are hard facts and must be bowed to and humbly sought. (ii) He must have precision in measuring the time, place, order and duration of the occurrences under observation. For this purpose instruments of measurement like the telescope, chronometer, thermometer and a thousand others invented by modern science are of great value. They extend the range as well as increase the exactness of observation. However, the merits and defects of the instruments themselves must be ascertained before they are used. The real scientist is a master, not a slave, of instruments. An expert will achieve far more with inferior apparatus than an amateur can hope to achieve with the best apparatus. (iii) The observer must have the sagacity to pick out the relevant circumstances for closer observation ;

otherwise there would be waste of time and energy. The physician need observe the circulation of the blood but not the movement of the tides in the ocean. (iv) He must observe under *utmost variation* of circumstances. For example, if the cause of a certain disease is to be investigated, it must be observed in patients of different age, habits, climates etc. (v) The observer must *isolate* the phenomenon completely or partially as the case may admit of. For instance, in order to study the effects of a drug, it should be administered alone by itself. Friction though incapable of complete elimination admits of partial elimination.

(4) Fallacies incident to Observation

As above remarked, observation is a personal affair. In order, therefore, to serve the best interests of science, one should guard oneself against the tendencies to error in personal observation. Partiality on account of special interest or prepossession must be avoided and minimised. People find it harder to give up a theory than a fact, and so facts are hushed into the theory. So it happened with the theory of Phlogiston. This was regarded as a substance having negative weight, in order to account for the increase in weight by burning of a body. Phlogiston, it was supposed, escaped from the body and being negative increased the weight of the body it left ! Impartial investigation found the correct solution and the phlogiston theory met its death. (2) Another tendency of the human mind is to lose sight of the proper sequence of events, particularly, in the observation of exciting events like a battle or an affray on the street. (3) There is also the tendency, already noticed, of confusing inference with fact. They must be ept as apart as possible.

There are two main fallacies incident to observation, namely (1) Non-observation and (2) Mal-observation. Non-observation consists in the failure to see what ought to be seen. Either the *relevant instances* or the *negative instances*, or the *operative conditions* are not observed. Prof. Minto has told how he thought to be going late to college when he looked at the tower-clock on the way. What had really happened was that the clock had stopped some hours before and Prof. Minto only looked at the minute-hand and was misled into thinking that he was late, though he was quite in time. When dreams are called prophetic, generally those which have come out true are remembered but a thousand others that were untrue are not noticed. A pointed illustration of the fallacy of non-observation has been stated by Bacon. In a famous temple of a Goddess, situated on the sea-coast, a traveller was shown by the priest thousands of memorials raised by travellers who were saved from ship-wreck after praying to the goddess, upon which the wary traveller put the question, "And where are the million other memorials of those who after praying perished?" Mill illustrates the fallacy by alluding to the commonly accepted theory that prodigality encourages industry. The best illustration of how the real operative conditions may go unobserved is afforded by 'Digby's powder' which cured a wound by being applied not to the wound but to the weapon that had inflicted the wound. The wound was really cured in the course of nature by being left unmolested. Bacon points out, "Men mark when they hit and never mark when they miss;" and in the words of Latta and Macbeath, "The whole race of prophets and quacks live on the overwhelming effect of one success compared with hundreds of failures which are unmentioned and forgotten." The other mistake is mal-observa-

tion which consists in observing what is observed in a wrong manner, that is, in interpreting wrongly what is observed. Tricks of jugglery and ventriloquism; optical illusions, for example, the mirage; what is called 'reading between the lines,' are all instances of mal-observation. Mill cites the theory of the sun moving round the Earth as an example of this fallacy. "The Exaggerated Comparison" is also a case of mal-observation. It is a matter of common experience that a thing appears bigger when compared to a smaller, and smaller when compared to a bigger, than it actually is.

(5) Hearsay and Traditional Evidence

In some departments of study like History, Sociology, etc, direct observation is Impossible and the investigator has to fall back upon hearsay evidence or testimony and traditions. Such evidence has to be accepted with great caution and discount, because, the errors of personal observation are augmented by the errors of the witness and the narrator. That is why in the administration of law more witnesses than one are generally required. Messages carried orally are hardly ever accurate. They are distorted on the way by the transmitters. Written records of ancient times are very doubtful and have to be sifted with great care. In accepting testimony the following tests should be applied:— (1) Veracity of the witness. Generally, the motives to tell a lie are, love of exaggeration, which accounts for much of the distortion of a message carried orally, natural attraction of the marvellous, which accounts for most ghost-stories, and self-importance and self-interest from which even the best of men are not exempt. About one and the same meeting, the reports of the newspapers belonging to two opposite parties will be widely divergent. (2) Another test is, sincerity of the witness. 'Jokes' are not to be taken seriously,

(3) Accuracy of observation possessed by the witness, which varies with age, intellectual capacity etc. (4) Partiality, to which every person is liable. (5) Power of recollection, which generally varies inversely with the time-interval. (6) Special capacity of the witness, which justifies the greater reliance placed on one expert's evidence than on that of many ordinary witnesses. (7) What is named 'antecedent probability' *must be taken into consideration; for instance,* a Promissory Note bearing a stamp of a date later than the professed time of the writing of the Note is to be discredited.

Traditional evidence is of two kinds, namely, written and oral. With regard to written evidence, the authenticity, integrity, and the date of the writing must be accurately ascertained by internal and external evidence. Oral traditions are especially hard to test. At the most, they give only general indications. Attempts have been made to lay down certain time-limits. "Seven years," "One generation," "Sixty years" are some of the criteria suggested for the correctness of evidence. But no fixed rules can safely be laid down. In this connection, an oft-committed fallacy is the "Argument from Silence" which amounts to proving non-existence from absence of any mention. This is a very hazardous *inference*, as every existing thing is not bound to find a place on record.

QUESTIONS ON CHAPTER V

1. Define "Scientific Observation" and "Experiment." How would you distinguish Experiment from Observation ?
2. Describe the advantages of Experiment over Observation.

3. Which mental and moral qualities must be possessed by a good observer (or Experimenter) ?
4. Mention and illustrate the fallacies incident to Observation (or Experiment.)
5. Write notes on :—
   (1) A Crucial Instance or Experiment
   (2) Natural Experiment
   (3) Blind or Negative Experiment
6. What are the tests to be applied to hearsay evidence ?

CHAPTER VI

HYPOTHESIS

(1) Meaning of Hypothesis

After the data supplied by observation has been classified, the next step, in the scientific investigation, is generally to frame a hypothesis. The word 'hypothesis' is used in a variety of meanings. In mathematics, it means 'abstraction.' The idea that a line has only length but no breadth is said to be a hypothesis. Similarly, a case, which though not known to be in existence, is assumed for purposes of elucidation of some principle, is said to be a 'hypothetical' case. However, 'Hypothesis,' with which we are concerned in a scientific investigation, has a different meaning. It may be defined as "a supposition, made on slight evidence, employed provisionally in scientific inquiry in order that we may deduce from it conclusions agreeing with actual facts." Mill defines it as "a conjecture not completely proved." But, as Prof. Minto points out, it is not necessary to restrict the word to incompletely proved conjectures but may be applied to any conjecture, whatever its future fate may be.

(2) Uses of Hypothesis

The uses of Hypothesis are manifold :-

(1) It may "colligate" or bind together facts and thus introduce some order, even though it may be false, as did the phlogistic theory previously mentioned. (2) It may give a *probable* explanation where otherwise no explanation is available. Thus Darwin's hypothesis of Evolution offered some sort of solution where there was no solution at all. In ordinary life, also, we use some hypothesis in order to allay doubts and find some solution out of a practical difficulty. (3) It may lead to a true theory as it did with Kepler who framed better and better hypothesis about planetary motion till he reached the hypothesis of elliptical motion. Even a hypothesis that fails paves the way for a better hypothesis. That is why Prof. Minto remarks, "The more (hypotheses), the merrier;" and Prof. Mellone approvingly quotes, "The first thing is to form a hypothesis; the second to be dissatisfied with it." A true scientist is always revising, modifying or even rejecting old hypotheses. (4) Lastly, a hypothesis may itself become an established theory, as did Kepler's elliptical hypothesis of planetary motion, or Newton's hypothesis of Gravitation (long laid aside before it came out true).

(3) Kinds of Hypotheses

A hypothesis may be one of *cause* or of *law*. If the cause or agent is unknown a hypothesis may be made about the cause, as was the the atomic theory about the constitution of things; or the conditions being known, the hypothesis might be of their *collocation*, as was the hypothesis of "the Solar system." Hypotheses in matters pertaining

to Sociology are generally of *Collocation* of conditions. Secondly, a hypothesis may be about a law, that is to say, about the process of the working of the cause. Such a hypothesis is called a descriptive hypothesis. The Gravitation hypothesis and the hypothesis about the mosquito being the carrier of malaria are instances of hypotheses of Law. Of course, a hypothesis may be of both kinds (Cause and Law) at once, as the Undulatory theory of Light (ether being the medium, and undulation the process). A hypothesis that is known to be false and yet adopted for the time-being for pushing on the work of investigation is called a "working" or provisional, hypothesis. Bain calls it a "Representative fiction." Even a "working" hypothesis is of immense value. It serves "to connect men's thoughts on the subject and to sustain their interest in working it out." According to Whewell, such hypotheses are not only useful but "necessary." As instances of working hypotheses may be cited the vortex-theory of Descartes, the geo-centric theory, the electric fluid theory, etc. On the other hand, a hypothesis which is incapable of being proved or disproved or being made more or less probable is said to be a "*barren*" hypothesis.

(4) Origin of Hypothesis

There is no mechanical way of forming a hypothesis. It is chiefly "the work of the scientific genius." "There is such a thing" writes Prof. Mellone, "as genius in science as well as in poetry and art." It is often by a flash of imagination that hypotheses of far-reaching consequences are formed. Newton's passage from the falling apple to the "falling moon," and Watt's passage from the lifted lid of the kettle to the steam-engine, are standing illustrations of the part imagination plays in scientific discoveries.

As Tyndall says, imagination is the "divining rod of the man of science." Prof. Minto writes, "Call it wha we will, the faculty of likely guessing, of making probable hypothesis, is one of the most important of the scientific man's special gifts... The right explanation may be reached in a flash....It may occur in a moment, as if by simple intuition, though it may be tedious to prove.... Without originality and fertility in probable hypothesis nothing can be done." And in the same strain, Prof. Careth Read says, "Some men seem to have a marked felicity, a sort of instinctive judgment even in their guesses." However, it is no less true that these "visions" occur only to those whose imagination is *prepared* to receive them, to those who have studied the subject with great care and patience. They occur, generally, to the man who has a wide knowledge of the subject, who has made immense observations of facts, to a man like Newton, or Darwin or Pasteur. Though the first inception of a hypothesis lies in imagination, the future progress of it, in the form of verification or proof, requires great patience, accuracy, impartiality and ingenuity in devising experiments; otherwise, even "brilliant conjectures, if they flash across the 'unprepared' mind are apt to remain fruitless." For instance, though Perraudin, the Swiss hunter, *conceived* the idea that the huge boulders in the valley were due to glacial action, it was a geologist who *proved* it. Hypotheses are very often suggested by Imperfect Induction and Analogy.

(5) Conditions of a Legitimate (or valid or sound) Hypothesis.

Before a hypothesis is accepted for scientific investigation, it must satisfy a few preliminary conditions:—

(1) Negatively, it must not be inconsistent with already ascertained facts or laws. Positively, it must be applicable to *all the facts* which are tried to be explained by it. Otherwtse, as Dr. Fowler puts it, "a perverted ingenuity" might frame numberless hypotheses. As an instance of such 'wide' bypothesis may be cited tbat of Design in Dialects.

(2) It must be capable of being brought into accord with received knowledge; that is to say, it must be capable of verification or disproof or at least of beiog made more or less probable. This implies Mellone's tbird condition, namely that, it must furnish a basis for deductive inference. More briefly, this condition is stated as 'the hypothesis must he *verifiable,*" This condition is sometimes expressed hy sayiog tbat a hypothesis must be 'conceivable.' But if 'conceivable' means 'self-consistent' it is unnecessary; and if it means 'easy to imagine', tben it would not be a true test. When Newton said that hypothesis should be a '*vera causa*' and when he said, "Hypothesi non fingo" (I do not imagine or *invent* hypothesis), he had really this condition in miod. The phrase, "vera causa" has been objected to by Dr. Fowler, and defended by Prof. Minto. Dr. Fowler objects to the word 'causa' by pointing out that a bypothesis need not be 'causa' as it might as well be about the law; and he objects to the word 'vera' on the ground that if 'vera' meant 'actually visible' then maoy useful bypotheses (like the centre of the Earth, Ether, etc.) would have to be dismissed. Prof. Minto points out, in reply to this criticisim, that 'vera' in Newton's pbrase does not mean that the hypothesis must necessarily be 'open to observations,' but only that it must not be supernatural or fanciful; in other words, it must be capable of being brought into line with other experience. Newton aimed the rule at

the Cartesian hypothesis of Vortices, which was too fanciful. As illustrations of the breach of this second condition may be cited the following hypotheses;--(i) The hypothesis that the sun travels in a chariot driven by seven horses (ii) The Solar and Lunar eclipses are due to demons (iii) The crystalline spheres. Such hypotheses are merely freaks of imagination, and incapable of proof or disproof. But Darwin's hypothesis of Evolution by Natural Selection is admissible because it is capable of being made " more or less probable. "

(3) The hypothesis must be *sufficient* and *adequate* (adequata causa). Generally, a breach of this condition is also a breach of the second. The suggested cause should not be ridiculously unequal to the effect. For example, Voltaire's theory, (probably put forward in joke) that the shells found on mountain-tops in central Europe were dropped by pilgrims returning from the East, cannot account for either the large number of the shells, or the nature (of being imbedded in rocks) or the distance from the beaten tracks or the difference from eastern specimens.

(4) Lastly, a hypothesis should *not be gratuitous* or superfluous. When known causes are sufficient to explain an event, unknown or extraneous or additional causes should be rejected as " not wanted. " For instance, the Moon's light being properly explained as due to reflection, the hypothesis of crystalline filling is superfluous and hence to be rejected. This rule is based on the Law of Parsimony (i. e. Economy). These conditions of a sound hypothesis are mentioned in different ways by different writers. Prof. Carveth Read lays down only two conditions or c *validity* of a hypothesis, namely, (1) It must be *verifiable* and (2) It must be *definite*; the others e. g. (1) Consistent with present experience (2) Real (3) Adequate and (4)

Exclusive, he puts down as the conditions of the *proof* of a hypothesis. Prof. Jevons mentions three "requisites of a good hypothesis":— (1) Possibility of Deductive reasoning from it (2) Consistency with the Laws of Nature and (3) Conformity with facts.

(6) Verification and Proof of a Hypothesis

A hypothesis is said to be verified when the consequences deduced from it are observed to agree with the facts of Nature. A striking illustration of such verification is afforded by the discovery of Neptune in 1846. The hypothesis of an unknown planet was suggested by aberrations in the movement of other planets. Mathematical calculations were made which fixed the place of the unknown planet and the telescope being directed to that place, the planet (called Neptune) was seen. But *proof* of a hypothesis may be distinguished from mere verification. Verification gives *a* cause but not *the* cause, so that strict proof lies in showing that the given hypothesis and that alone is true. This can be done by crucial instance or experiment or by the Methods (to be explained next) or by showing the given hypothesis to be a deduction from a higher law. For instance, the elliptical hypothesis of planetary motion became an established theory when it was shown to be a special application of the Law of Gravitation.

Dr. Whewell applies three tests for determining the truth of hypothesis, viz. (1) *Explanation* of existing facts (2) *Prediction* of future events (3) and *Consilience* of Inductions. Comte also said, "Prevision is the test of true theory." But Dr. Fowler and Prof. Carveth Read have shown that mere prediction cannot be accepted as the test of truth; for "cases can be produced in which erroneous hypotheses have led to prediction;" for example, the

Ptolemaic theory in Astronomy and the Phlogistic theory in Chemistry led to correct predictions and yet these hypotheses have turned out to be erroneous. Consilience of Inductions also is not a sure test. When a hypothesis enables us to explain and determine cases of a kind *different* from those which were contemplated in the formation of the hypothesis, when rules springing 'from remote and unconnected quarters ' leap to the same point,' this jumping together is called " Consilience of Inductions " or " Extension of the hypothesis." The Theory of Gravitation is a good example of consilience. It explains not only the fall of bodies on the Earth, and the orbits of planets, but such distant phenomena as the tides, the comets, the double stars, etc. But even consilience of Inductions, though it increases the conviction, is not *proof*, as the possibility of vicarious (alternately plural) causes is not precluded. Dr. Fowler concludes his criticism of *consilience* in these words, " It is undeniable that a theory which thus appears to afford an explanation of different classes of facts strikes the imagination with considerable force, and that its very simplicity furnishes prima facie evidence of its truth. But what is required before a hypothesis can be placed beyond suspicion is *formal proof*, and that, it appears to me, is furnished by Mr. Mill's methods and not by Dr. Whewell's requisitions of " explanation, prediction and consilience of Inductions. "

(7) Importance of Hypothesis

The great importance of Hypothesis in science may be summarily stated in Jevons's words, " All Inductive investigation consists in the marriage of hypothesis and experiment " (P. 504, " The Principles of Science ").

Carveth Read writes, " Hypotheses are essential aid

to discovery; speaking generally, deliberate investigation depends wholly upon the use of them" and further, "As a rule, when inquiring deliberately into the cause of an event, whether in nature or in history, we are guided by a preconception, that is, by an hypothesis." Dr. Whewell praises hypothesis so much that to him Induction is nothing but hypothesis. The inductive process, according to him, "consists in framing successive hypotheses." On the other hand, some eminent thinkers have had a strong prejudice against hypothesis; for example, Bacon and Newton disparaged it. Bacon's method has no place for hypothesis. It consists in accumulating and "tabulating" facts of observation and drawing 'orderly abstractions' from them. Newton also passed sarcastic remarks on Hypothesis, though he made use of it himself. Mill also speaks of the "Hypothetical Method" (which according to him consists of Induction, Ratiocination and Verification) as if it were defective and to be adopted only if his "Experimental Methods" were inapplicable. There is no doubt that Mill's Methods (to which we have next to turn) give a neat, formal *proof;* but so far as new *discoveries* are concerned, the Method of Hypothesis is almost indispensable. Mill, in short, overestimates his own methods and underestimates the hypothetical method. Prof. Minto writes, in defence of Mill, "The dispute beween Mill and Whewell was in the main a dispute about words. Mill did not really undervalue hypothesis." The conclusion at which we may arrive is this, that the Method of Hypothesis (which will be fully described later) is indispensable for *discovery*, but before a hypothesis can take the place of an established theory, it must not only be verified but formally *proved*, and for so proving it, the "Experimental

Methods " formulated by Mill are of great service. To these Methods we must now turn.

QUESTIONS ON CHAPTER VI

1. What is meant by a hypothesis in science ? What are its uses and kinds ?
2. How are fruitful hypotheses formed ?
3. Mention and illustrate the conditions of a sound hypothesis.
4. Distinguish between verification and proof of a hypothesis. Which tests are suggested by Whewell ? On what grounds are they criticised by Fowler ?
5. Estimate the importance of Hypothesis in science.

CHAPTER VII

THE DIRECT INDUCTIVE METHODS

(1) Introductory

"The problem of Induction" writes Dr. Fowler, "resolves itself into the problem of detecting facts of causation." For doing so, Mill formulates *five* Methods *which have been called by him "Experimental Methods,"* as contrasted with the Indirect (or Hypothetical) Methods which contain an admixture of Deduction with Induction and are looked upon by Mill as somewhat defective.

These direct Methods may be said to rest on the dictum of *elimination*, namely, "Nothing is the cause of a phenomenon in the absence of which it occurs or in whose presence it does not occur."

The five methods are called by Mill by these names;- (i) The Method of Agreement, (ii) The Method of Difference, (iii) The Joint Method of Agreement and Difference. (iv) The Method of Concomitant Variations and (v) The Method of Residues.

Mill himself explains that, of these, two are primary Methods, *namely, The Method of Agreement and the* Method of Difference, the Joint Method is a double application, the Method of Concomitant Variations is a quantitative application of either of the two primary Methods, and

the Method of Residues is a variety of the Method of Difference. An elucidation of these Methods must precede any criticism of them.

1. THE METHOD OF AGREEMENT

(1) Canon of the Method of Agreement

The Cannon of the method of Agreement has been thus stated by Mill.

"If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree is the cause or effect of the given phenomenon."

Dr. Fowler modifies the canon by the phrases, "with more or less of probability" and "or at least connected with it through some fact of causation," which bring out at once the limitations of the method.

(2) Symbolic Representation

Supposing A to be investigated, and the following instances are observod,

Abcd, Aefe, Aghc,

it may be concluded by means of this Method that A and c are probably causally connected.

(3) Method of Agreement different from Imperfect Induction.

The Method of Agreement resembles simple Enumeration in its reliance on a number of instances, but it differs from it in the stress laid on the *variety* in the accompanying circumstances. It is not repetition, but *variation*, that is essential here. It is not merely the observation of Ac *many times*, but the observation of Ac alone being the common factors in a multitude of other *changing* factors, that makes the application of this Method possible.

Of course, many instances will have to be observed in order to be able to eliminate all but c.

(4) *Weaknesses of the Method of Agreement*

This Method has many defects:–

(i) *In the first place, it is* difficult in application on account of the complexity of phenomena in Nature. A relevant circumstance may be overlooked. Events are not *marked* off into distinct and separate phenomena, as Mill's statement would imply. Moreover, a *strict* application of this Method, dependent as it is on observation, is extremely *difficult* as *rarely* can *instances be found where only one* material circumstance is common.

(ii) In the second place, 'plurality' of causes is also a serious obstacle to this method. For example, a person may get headache, once on account of the *raw* meat that he eats, another time, on account of the *fried* articles of food, a third time, on account of eating *stale* food, but every time he drinks water ; and therefore on the strict application of the Method, the headache is likely to be attributed to the one common circumstance of water (which, however, is inert). However, this difficulty is lessened by the multiplication and variation of instances.

(iii) In the third place, the Method *cannot afford* certainty, but only probability, (as it is not possible to exhaust all instances) which according to Mill, is its *characteristic defect. Dr. Fowler makes* this point clear in his enunciation of the canon itself.

(iv) In the fourth place, the method is powerless to discriminate between a causal connection and a case of co existence. Even if animals that ruminate are all seen to be cloven-footed, the two facts are not cause and effect but .

two consequences of a (third) cause. It is to show this vagueness about the conclusion that Fowler incorporates the last clause in his enunciation of the canon.

(5) Merits of the Method

But there are certain distinct advantages possessed by this Method. (1) Being a method of observation which is always easier than experiment, it is often the only available Method. As Prof. Mellone puts it, " This Method is applicable where our control over the phenomena under investigation is very limited, so that experiment is not possible. " (2) It is almost the only method for finding out the cause when the effect is given. In Prof. Mellone's words, " When our object is to discover the cause of a given effect, we are compelled, in the first place, to have recourse to the Method of Single Agreement. " (3) At any rate, it *suggests* the causal connection and paves the way for other and more effective methods. (4) Lastly, it is applicable even when more than two circumstances are common to the instances.

(6) Illustrations of the use of the Method

(1) What might be the cause of the North-east wind (in England) being injurious? " That wind is sometimes cold, sometimes hot; generally dry, but sometimes wet; sometimes violent, and of all electrical conditions; but it is *always a ground-current, laden with dust*. Therefore, this last *common* circumstance is probably the cause of its injuriousness. (Carveth Read, P. 207)

(2) Cause of the rainbow colours?

The rainbow colours were first seen produced by the passage of light through hexagonal crystals; afterwards also through dewdrops. spray of water-falls, etc. Therefore,

the rainbow colours were connected with *a transparent* globe or prism.

(3) Cause of Dew ?

Dew is seen on different objects; the common circumstance is the *coldness* of the surface of the objects on which it is seen. Therefore, the coldness has something to do with the production of dew.

(4) Countries which are self-governing are observed to be prosperous, however much they differ from one another in other circumstances; hence, self-government and prosperity are causally connected.

II. THE METHOD OF DIFFERENCE

(1) Canon of the Method

Mill states the canon thus:—

"If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring in the former, the circumstance in which alone the *two instances differ is the cause* or an *indispensable* part of the cause of the phenomenon."

With respect to this statement of the Canon, Prof. Minto has rightly pointed out that Mill's Canon suggests that the two instances *must* be two separate sets of circumstances and Mill's *illustration* of the use *of the Method to* find out the "effect of Protection on National Wealth" strengthens this suggestion. It is this requirement that makes Mill think that this Method is not applicable to social affairs. But two independent sets of circumstances are not necessary. One and the same *instance, once with the* presence of a circumstance and once with the absence of it, will suffice. However, the improvements suggested by Prof. Minto and Prof. Mellone, in Mill's canon, are otherwise unnecessary.

(2) Negative Instance

An essential requirement of this Method is *two* instances, one positive and one negative. By a positive instance is meant one in which the phenomenon to be accounted for is *present;* by a negative instance is meant one in which the phenomenon under investigation is absent. However, to be a negative instance, it must be an instance in the same subject-matter, in *pari materia*, as it is said; otherwise it is irrelevant and therefore, not worth being taken into consideration. So, a negative instance is a *relevant* (that is, otherwise similar to the positive) instance in which the phenomenon under investigation is *absent*

(3) Symbolic Representation

bc produce yz;
but Abc produce xyz;
therefore, A is the cause or part of the cause of x.

(4) Difficulties in the application of the Method

In the first place, there is the difficulty in *controlling* all the circumstances. What is required is the introduction of only *one* new circumstance; but in introducing one circumstance, others, too subtle to be observed, may enter in, as they did in Pouchet's experiment (above referred to) on generation. In that case, living organisms had entered through mercury, unknown to the experimenter who had otherwise excluded them; and this led him to the theory of 'spontaneous' generation. In human affairs such extra circumstances cannot be prevented from entering. In considering, for example, the effects of Protection on National Wealth, if two countries, one having protective measures and the other not, or one and the same country with protection and without it, are compared, the application of this Method may be frustrated by many new

factors like War, Taxation, Currency, Mines, Railways, etc. Moreover, the new factor must not itself alter in the process of being introduced. Delay is sometimes very dangerous. It is also difficult to ascertain *all* the antecedent conditions, with the consequence that a result may be attributed to a wrong circumstance or antecedent. If a person hot by working in the fields in summer heat runs to a well and drinks water and soon after falls down dead, the death may be attributed, by means of this Method, to the drinking of water; and the antecedent heat, which is really a relevant circumstance, may be neglected. Such a neglect is called the fallacy of *non ceteris paribus*. For example, in a certain hospital in Dublin, there was a higher rate of mortality among the patients in the ground-floor wards. This was naturally attributed to the dampness etc. of the ground-floor; but it came to be known that the hospital-warden used to lodge 'serious' patients on the ground-floor. Their higher mortality was therefore not really due to the atmosphere. Similarly, when water was decomposed it resulted into oxygen, hydrogen, *and* acid and alkali. But it would be wrong to conclude that this is the analysis of pure water. The acid and alkali were due to impurities in the water taken for decomposition. Thus, the antecedent circumstances are likely to be mistaken. In the second place, the Method helps us to know *a* cause but not *the only* cause, that is to say, the plurality of causes is not excluded. In order to find out the only cause, this method must be supplemented by the Joint Method (to be next considered). In the third place, it may not enable us to know the whole cause, but only a part of the cause. The circumstance introduced or withdrawn is not necessarily by itself the whole cause of the change in the consequences. For example, A producing x and Ab produicng xy is no proof of b being the cause of y, separately. This is especi-

ally to be noted in chemical compounds and in human affairs. For example, if five men are unable to lift a beam, and one man added, the beam is lifted, it is not the sixth man that lifts the beam. *The six* men are the cause, the sixth man being a part of the cause only.

(5) Advantages of the Method

There are however distinct advantages of this Metbod. (1) If applied successfully, it gives a cause or part of the cause *with certainty*. (2) Being essentially the Method of experiment, (as it presupposes our control of tbe circumstances), it is very useful in determining the *effect* of a given cause. (3) Being an experimental Method, repetition is not necessary; time and energy are saved.

(6) Illustrations of the nse of the Method

Tbe Method of Difference is of constant application in everyday life :–

(1) Tea witbout sugar is tasted and tastes bitter; sugar is added and allowed to melt; the tea is tasted again and this time tastes sweet. That sugar is the cause of sweetening is known by tbe application of this Method.

(2) There is pain in the foot; the lacing of the boots is relaxed and the pain stops; hence *tight lacing* was the cause of the pain.

The Method is, however, more fruitfully applied in sciences like Chemistry and Physics. Dr. Fowler says, " There is no science perhaps in which the Method of Difference is so extensively used as the science of Chemistry, and that because Chemistry is emphatically a science of Experiment."

(3) A piece of litmus paper when dipped into acid turns red at once while another piece of litmus paper not dipped into acid (but into water or some other liquid)

does not turn red. The acid, then, is a condition (i. e. at least a part of the cause) of its turning red.

It is often by means of technical aids (like the airpump in the guinea-and-feather experiment) that the requirement that only one circumstance should be different is secured. Thus

(4) (From Physics) A guinea and a feather are let loose at once from the same height. The guinea reaches the ground much earlier than the feather. Again, by a contrivance, they are let loose at once from the top of a glass-jar from which all air has been pumped out, that is to say, in vacuum; they reach the bottom together. Hence, the air retards the motion of objects.

(5) (From Physiology) One gets one's self inoculated (say, against plague); next day one gets headache, temperature, etc. Hence, the inoculation is the cause of the headache, fever, etc.

(6) (From Biology) If a freshwater crayfish, having its antennules (small feelers) intact, retreats from strong odours, while another, bereft of them, does not react to strong odours at all, then it may be inferred that the antennules are the seat of the organ of smell in the crayfish.

(7) (From Agriculture) If in two adjoining pieces of land of equal size, the same crop is reared, but in one piece, a particular manure is thrown and the crop in that piece is seen to be more abundant, the richer quality of the crop may safely be attributed to the manure.

Even in Economics, this Method can be applied, though with greater difficulty. Thus

(8) If increase of taxation is seen to be followed by increase in the prices of articles, other economic conditions practically remaining the same, then the increase of prices can be inferred to be due to increased taxation.

(9) Prof. Carveth Read adduces an interesting example of the application of this Method, in the sphere of Economics. In 1841, English and French workmen were employed on railway work. Their capacity for work was different and it was suggested that the difference in diet was responsible for it. "An experiment" was done by interchanging the diet and the working capacities also changed. It was concluded that diet was the cause of the working capacity.

III. THE JOINT METHOD OF AGREEMENT AND DIFFERENCE

(1) The Canon

The Canon of the Joint Method as stated by Mill runs thus:—

"If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance, the circumstance in which alone the two sets of instances differ is the cause or the effect or an indispensable part of the cause of the phenomenon."

Mill rightly understands the necessity of this method to prove *the only cause* of an effect. For this purpose, an *independent* investigation into all the negative instances, (instances in which the suspected cause and effect are both absent) is necessary. But Mill's statement of the canon is very defective.

(1) In the first place, though Mill calls it the Joint Method of Agreement and Difference, there is no indication of the application of the Method of Difference, because the positive instances are to be supplemented (according to

Mill's canon) by negative instances, by means of observation and not experiment. Thus this Method of Mill's is really a double method of Agreement–Agreement in presence and Agreement in absence. It will be a real Joint Method, if the negative instances supplement the previous application of the Method of Difference. Prof. Mellone, therefore, lays down the following canon for the strict Joint Method. "When one phenomenon has been shown to be the cause of another under given conditions, by the Method of Single Difference, and when we *fail to find or construct any instance* where the one phenomenon occurs without the other, then it is probable that the first is the ' unconditionally invariable antecedent ' of the second.

(2) Secondly, Mill's statement is vague, as it does not make it clear that the negative instances must be in pari materia (the same subject-matter).

(3) Thirdly, only *two* positive instances will not suffice.

(4) Fourthly, it is not necessary that the negative instances should have " nothing else in common. "

(2) Symbolic Representation

(According to Mill's Canon of the Method which may be called the *Double Method* of Agreement)

Positive instances	Abcd – efgh
	Aijk – elmn
Negative Instances	opq – rst
	uvw – xyz

Therefore, A is very probably the cause and the only cause of e.

(According to Mellone's Cannon of the Method which is the real Joint Method of Agreement and Difference).

Abcd – efg	Positive
bcd – fgh	Negative
bopq – lrst	Negative
cuvw – mxyz	
kerd – tqrs	

Therefore, A is the cause and the only cause of e.

(3) Difficulties in the application of the Method

This being a Joint Method will have the same difficulties as the Method of Agreement and of Difference have, namely, the difficulty of getting the positive instances to agree only in one circumstance and the difficulty of exhausting the field of probable causes, in negative instances, which an expert alone can determine. Prof. Mellone remarks, " The extent of the field over which we must range in assembling negative instances is a question which the trained investigator alone can decide. "

(4) Advantage of the Method

As the method implies an exhaustive and searching analysis, it has the great advantage of discovering the *exclusive* cause. For this reason, Mellone calls it " the fundamental method of science " and all other methods as " imperfect approximations to it. "

(5) Illustrations of the use of the Method

The " Double Method " may be illustrated by the following examples:—

(i) Darwin's theory that earth-worms alone are the cause of the vegetable mould Darwin observed that many plots of land containing all of them plenty of earth-worms, although otherwise very different in character, became covered with vegetable mould; on the other hand, many other similar plots, deficient in earth-worms, did not get covered with vegetable mould.

(ii) Wallace's theory that the white colouration of the arctic animals is protective : It was observed by him about animals living in the arctic regions that the bear, the hare, the owl and the falcon were all white in colour; the sable was not white but brown, but as it lived on trees, it required

no protection; the raven was black, but it feared no enemy; the musk sheep also was brown, hnt living in herds, it, too, did not require protective colouring.

(iii) The real Joint Method, containing, as a part of it, the Method of Difference, is dependent on experiment and therefore available in sciences like Chemistry from which Prof. Mellone adduces his illustration of the yeast-cells being the cause (and the only cause) of fermentation [P. 310-311, 18th Edition]. Prof. Mellone points out that the positive instances were produced by Gay Lussac and Schwann, and the negative, by Hoffmann and Helmholtz.

IV. THE METHOD OF CONCOMITANT VARIATIONS

(1) The Canon of the Method

Mill states the canon thus, "Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or is connected with it through some fact of causation."

This Method is a *modification* either of the Method of Agreement or of the Method of Difference, according as only positive instances or both positive and negative instances are available. Prof. Mellone thinks it necessary, in expressing it as a modification of the Method of Agreement, to add the words, "other circumstance varying quite independently or with no correspondence" owever, these words may be taken as understood in Mill's statement.

(2) Symbolic Representation

(As modification of the Method of Agreement)	(As modification of the Method of Difference)
Abc — xyz	Ab — xy
2 Abe — 2 xgh	2 Ab — 2 xy
3 Akl — 4 xmn	3 Ab — 4 xy
Therefore, A is probably the cause of x; and as A changes in Arithmetical progression, x does so in geometrical progression.	Therefore, A is the cause of x; and as A changes in Arithmetical progression, x does so in geometrical progression.

(3) Necessity and Advantages of the Method

(i) Where complete elimination of a certain factor is impracticable, but its increase or decrease is possible, this Method is applicable, as a *substitute* for the Method of Agreement or that of Difference. For example, heat, friction, gravitation etc. cannot be completley annihilated, but can be appreciably reduced; and any variation in the attendant circumstances can be attributed to these agents. Thus, the First Law of Motion really rests on the application of this Method. (ii) Secondly, even if the causal connection is already known, this Method enables us to ascertain the exact quantitative correlation between phenomena. Thus, the *Law* of variation is determined by this Method. The tendency of modern science to be quantitatively exact has given special importance to this Method. "Every question in Science," says Jevons, "is first a matter of fact only, then a matter of quantity, and by degrees becomes more and more precisely quantitative." (iii) An additional advantage of this Method consists in the ease with which it lends itself to a *graphic* (i. e. by means

of graphs) representation of phenomena. (iv) The Method, is applicable even where *exact* measurement is not possible, as in Sociolgy, Geology, etc. where the phenomena are too complex to admit of an exact calculation. Even if some *periodic* change is observed, the case comes under this Method. As applied to social or historical or economic affairs, the Method is called " the Comparative Method. " For example, if in an otherwise stable society, as illiteracy diminishes, crimes also are seen to be less, then illiteracy may be looked upon as a cause of crime.

(4) Limitations of the Method

(i) The Method yields only an " empirical law " or a law which is true only within observed limits. Beyond the observed limits, the law of variation may not apply at all, or may apply differently, or even reversely. For example, the law that cold contracts bodies does not hold uniformly true in the case of water. Below a particular temperature (32°), cold expands it instead of contracting it. The Law holds best within the median range. One has, therefore, to be very careful about the extension of the law discovered by this Method to unseen cases. The law changes at what are called " critical points " owing to " progressive effects. " It is well known that it is *the last* straw that breaks the camel's back. The Law might be a highly complex one. (ii) So also, only *two* circumstances must change; or if a third one does, it must be known definitely to be changing independently, like time: otherwise, co-effects are likely to be construed as cause and effect. For example, though the intensity of the light and the loudness of the thunder change proportionately, they are not themselves cause and effect, but only, as pointed out by Mill in his Canon, connected by some fact of

causation. (iii) The phenomena must change quantitatively, that is to say, the qualitative change must be capable of being quantitatively measured (if not exactly, at least, roughly), otherwise the Method is not applicable. For example, if A is seen to produce x; and 2 A is seen to produce y, nothing can be inferred unless there is a quantitative relation between x and y.

(5) Illustrations of the use of the method

(1) When heat is increasingly applied to a solid, it is seen to become a liquid and afterwards a gas. Heat is, therefore, the cause of the change of form of the substance. (2) Dr. Fowler narrates (P. 193-194) how the *periodic* elevation of the temple of Jupiter Serapis at Pozzuoli, on the Bay of Naples, led to the discovery that heat under the surface (and no magic) was the cause of the elevation. (3) When psychologists set up a causal connection between the convolutions of the brain and the intelligence, they do so by the application of this Method. (4) That the variation may be inverse is well illustrated by the principle of demand and supply in Economics.

V. THE METHOD OF RESIDUES

(1) Canon of the Method

The Canon stated by Mill is "Subduct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedent."

As the Method, more often than answering, *raises* the question of the cause of a remainder (or residue), Prof. Mellone gives one more canon to suit the latter purpose, namely, "When any part of a complex phenomenon is still unexplained by the causes which have been assigned, a further cause for this remainder must be sought."

(2) Symbolic Representation

(To suit the first form)	(To suit the second form)
Abcd – efgh	– efgh
b – f.	– b – f.
c – g	c – g
d – h	d – h
Therefore, A produces e	Therefore, what is the cause of e ?

(3) Advantages of the Method

(I) The Method is a special application of the Method of Difference, especially where the phenomenon, though complex, is a *homogeneous intermixture* of effects. For example, friction, combustion, compression and electric action may all be contributing to the production of heat. If any of these are separately studied and their effects ascertained, the remainder of the effect can be known to be the effect of the remainder of the causes. This "intermixture" or combination of homogeneous effects may assume very complicated forms as the action of one antecedent may be augmented, diminished, diverted or counteracted by another. Every one of the causes, however, is working. When the effect of a cause is not visibly present, it is called a 'Tendency.'

(4) Difficulties in the application of the Method

(i) As it implies several preliminary inductions, it is applicable only at an *advanced stage* of knowledge.

(ii) It is applicable only where *quantitative measurements* are possible. This is so where the effects are *homogeneous* and not heterogeneous.

(iii) The Method, in the first form, is deductive rather than inductive.

(5) Illustrations of the use of the method

(1) The weight of coal in a truck may be determined as a residual phenomenon if one knows the net weight of the empty truck and deducts it from that of the loaded truck.

(2) The discovery of Neptune in 1846 by Adams and Leverrier is a striking example of the application of this Method. Residual deviation in the calculated orbit of Uranus compelled astronomers to account for it and the planet Neptune was discovered to be the cause.

(3) Similarly, in Chemistry, argon remained undetected until the residual density of atmospheric nitrogen (that is, nitrogen obtained from the atmosphere by removing impurities, moisture, oxygen etc.) in comparison with chemical nitrogen (that is, nitrogen prepared from nitrous oxide, etc.) raised the suspicions of Lord Rayleigh and Professor Ramsay, in 1894.

(4) Water was known to be a combination of oxygen and hydrogen. The weight of oxygen was ascertained, by means of copperoxide, to be 87.89 per cent; so the proportion of hydrogen was known to be 12.11 per cent in the composition of water

(5) Norway, being to the north of Newfoundland, was expected to be colder but was actually less cold. This discrepancy suggested some counteracting agency which was discovered to be the Gulf-stream.

VI. GENERAL CRITICISM OF MILL'S METHODS

As the syllogism was severely criticised by Mill, Mill's Methods, in turn, have been severely criticised.

(1) The most damaging criticism is that Mill's Methods are deductive in their nature. C. Read, for exam

ple, says, "The formal logic of induction is essentially deductive." This criticism reveals the tendency to reduce all inference to the deductive (or syllogistic) type. But as observation (or experiment) is to supply the data to which the Methods are to be applied, the above criticism loses its point. The data of inference are quite different from the *major premise* of a syllogism.

(2) There is, however, much truth in Dr. Whewell's (and also C. Read's) objection that these Methods are difficult in application as they *presuppose* much preliminary work (of observation, classification, hypothesis, etc.) in order to obtain the required data. The most conclusive Method is the Method of Difference. But this Method, or the Method of Agreement, (consequently, the others which are combinations or modifications of these) cannot always be applied rigorously. When the phenomena, as so often happens, are not sufficiently under the control of the investigator, he may not be able to secure the precise kinds of instances required for the strict application of these Methods. As already observed, the actual phenomena are infinitely complex and Nature does not give us events marked off into distinct and separate phenomena. C. Read puts the objection trenchantly when he says, "As long as we are content to illustrate the Canons with symbols, such as A and p, all goes well; but can we in any actual investigation show that the relevant facts or instances correspond with those symbols? Hence the application of the Methods is the most difficult thing." In a similar strain, Prof. Mellone complains, "He (Mill) must have regarded these Methods as applicable *directly*, without any previous assumption, to the masses of fact which ordinary experience presents to us; by this means the facts are to be made to disclose uniform laws. This is just what the Methods will not do. They require *prepared*

material." It is especially difficult to obtain the releva negative instaoces.

(3) It must also be ohserved that the *five* Methods a *not separate* at all. The separate exposition of the sever methods is likely to he taken to imply that eacb of tbem usually, or should be, employed alone. But really, they a frequently employed in conjunction; and in their less coger forms it is not easy to distinguish ooe from anotber, say, th Method of Difference from that of Coocomitant Variation or from the Joiot Method. Mill seems to have recognisec this as he looks upon the first two of them as 'primary' anc the others as 'secondary.' But his exposition is no doub misleading.

(4) Another ohjection, urged hy Dr. Whewell, against the Methods is that *no actual discovery* has heen made by a conscious application of the Metbods. This criticism is somewhat irelevaot, because the Methods are not offered as methods of discovery, but of *proof*, that is, puttiog the discovery to the test.

(5) Lastly, it has heen pointed out, as for instance hy Prof. Mellone, that the utmost tbat the methods can do is to establish *causal connections* between isolated facts, but causal coonections are explanations of the most rudimentary form. So long as the causal connections are not further explained by means of some synthetical law, they remain merely empirical, having varying degrees of probability according to the nature of the Metbod or Metbods employed.

That tbe afore-mentioned Methods are not of much use when the phenomena are of a complex type was recognised by Mill himself who admits two or three otber (i. e. indirect.) Methods of investigation, thougb be gives them a secondary place.

QUESTIONS ON CHAPTER VII

1. What is the dictum on which Mill's Methods proceed?
2. Describe the Method of Agreement and give an example of its application. What are the inherent weaknesses of this Method?
3. Describe the nature, and the difficulties in application, of the Method of Difference. Show the superiority of the Method of Difference to the Method of Agreement.
4. What purpose is served by "the Joint Method?" Mention and explain the necessity of Mellone's revised Canon of the Joint Method.
5. Describe the character and special advantages of the Method of Concomitant Variations.
6. Describe the Method of Residues and illustrate its applications.
7. What general criticisms are levelled at Mill's Methods? How far are these criticisms justified?
8. What conclusions would you draw from the following accounts, and on which inductive Methods do you base your conclusions?

(1) Hot springs are irregularly distributed in various countries throughout the world—in America, Tibet, Japan, Iceland, the Azores, the Pacific Islands, etc. It is found, however, that they practically always occur in regions which are, or have been, scenes of volcanic activity.

(2) Two monkeys were made drunk, one with raw spirits, the other with matured spirits. The first became angry; it spat and it swore. The second was merely foolish

consequences to which it leads is that the Earth instead of being an exact sphere, must be flattened in the direction of its polar diameter, the one diameter being about thirty miles less than the other. Investigation showed this *conclusion to be true in fact*. The Law of Gravitation thus obtained an additional proof.

(2) The Combined methods

Mill himself mentions three methods in addition to his experimental methods. All his methods may be summarised thus--

1. Purely Inductive, i. e. "The Experimental Methods"
2. Purely Deductive, i. e. "The Geometrical Method"
3. Deductive-Inductive, i. e. "The Direct Deductive" or "The Physical method"
4. Inductive-Deductive, i. e. "The Inverse Deductive" or "The Historical method."

Out of these, "The Experimental methods" have been explained in the previous Chapter. As regards the purely Deductive or Geometrical method, it is not an Inductive method at all. It is sometimes ranked as "Induction by Parity of Reasoning," but this is no real induction at all. The remaining two methods require a combination of Induction and Deduction.

(3) "The Direct Deductive" or "The Physical Method"

According to Mill, "the Direct Deductive" or "the Physical Method" (so called because much relied on in Physics) consists of *induction, ratiocination,* and *verification.* Deduction leads the way and its results are tested inductively by experiments or observations." A combination of

causes is suggested to explain the phenomenon; and it is shown by observation or experiment on the causes, that their combination agrees with the facts. Sometimes, experiments made on a small scale may verify a big hypothesis. For instance, the hypothesis of Natural Selection may be proved by a few experiments on plants in a garden; the mirage or the rainbow, by an experiment in a laboratory. Mill grants that to this method "the human mind is indebted for its most conspicuous triumphs in the investigations of Nature.' Practically, it amounts to the Method of Hypothesis.

The *advantages* of this Method are that (1) it is a method of *discovery* as well as proof and that though called the Physical Method, (2) it is applicable everywhere. The detective and the judge have constantly to rely on this method for discovery and proof of offences. Guilt is very often proved not by direct but by "circumstantial evidence" which makes a particular person "fit in." Even a housewife who wants to find out the habitual stealer of the cheese must resort to this method. The thief might be the cat, the maid, or one of the children. The consequences must be deduced and verified. The Theory of Gravitation, the Undulatory Theory of Light, the discovery of Naptune, the discovery of argon, in fact, all great discoveries in science have been made by this Method.

Illustration:—

By mathematical reasoning Cavendish arrived at the conclusion that if the force between two electric charges varies inversely as the square of the distance between them (and in no other case), then electricity communicated to a body must collect wholly on its surface, so that the interior will be uncharged.

He placed one metal sphere inside another metal sphere in such a way that it was insulated independently, and then charged the outer sphere and connected it momentarily by a wire with the inner sphere. After breaking the connection, he tested the inner sphere with an electroscope but did not find it charged.

(4) " The Inverse Deductive " or " the Historical Method "

According to Mill, this Method consists in beginning " with an empirical law of the phenomenon and then endeavouring to show by deductions 'from the nature of the case,' that is, from a consideration of the circumstances and forces known to be operative, that such a law was to be suspected. Deduction is thus called in to verify a previous induction, whereas, in the 'Physical Method,' deduction is verified by induction.

This method is especially required when the phenomenon is not only complex but *remote*, in addition. The difference between the two methods, though made to depend on the order of deduction and induction, really turns upon the difference in the cogency of the results, the conclusion being definite in the first and indefinite in the second. The inverse order may be used in Physics too. It is called the Historical Method because it is largely used in explaining the movements of history. But it is also applicable in Geography, Biology,, etc.

As illustrations of the application of this Method, may be cited, (1) Mill's own theory that Peasant Proprietorship is the best. He first shows, *inductively*, by collecting evidence from various countries, that peasant proprietors are industrious, intelligent, prudent, temperate, etc. and then *deduces* these qualities from " the nature of the case, " industry from

ownership, intelligence from accumulated experience, prudence from social necessities, temperance from iudustry and prudence, etc. (2) "Democracies tend to change into despotisms" may, similarly, be arrived at inductively and corroborated by being shown to be the necessary consequence of human psychology. (3) "Civilisation of the country proceeds from the town" may first be a generalisation from observed facts and is then strengthened by being shown how it must be so from the nature of human society. The following is a complete illustration:—

"At the time of the American Revolution many Loyalists left their homes in the Southern States and went to the Bahamas, Other Colonists also went there from Great Britain. Now after several generations the descendants of these Loyalists show a larger proportion of degenerates than can be found in any other Anglo-Saxon community. The descendants of similar Loyalists in Canada are among its strongest elements; in the Bahamas they are scarcely ahead of the average negro.

And naturally so. For they lose in both physical and mental energy. This leads to carelessness in matters of sanitation and food, and thus gives greater scope to the diseases whieh under any circumstances would find an easy prey in their weakened bodies. The combination of mental inertia and physical weakness makes it difficult to overcome the difficulties arising from isolation, from natural disasters, or from the presence of an inferior race, and this in turn leads to ignorance, prejudice, and idleness."

This method is called "the Comparative Method" when applied to trace the development of a particular institution. For instarce, the present abhorrence of capital punishment may he shown to be the ontcome of the progress in moral ideas. Similarly, "As edncation spreads, crime lessens."

may be proved by comparative tables of different countries and of the same country at different stages of civilisation. The comparative method is the application of the Method of Concomitant *Variations to the* complex phenomena of economic and social Sciences. The comparative Method has to be applied with great caution as it is difficult to know all the relevant factors. For instance, though the institution of polygamy generally depends upon the ratio between the *number* of men and women in a country, Christian countries must be excluded from the application of the law, as monogamy is enforced on them by their religion.

(5) Uses of the Combined Method

What is important in the varieties of this Method is not the *order* of Induction and Deduction, but their *combination*. The Combined, or Deductive Inductive Method, is used for three purposes, namely, (*a*) The indirect verification of hypothesis (*b*) The systematisation of laws and (*c*) Mutual support of Deduction and Induction.

(*a*) Sometimes, an hypothesis, stating the possible nature of the connection between the phenomena studied, cannot be put to the test directly; only its consequences can be tested by observation or experiment in the light of already established knowledge. The indirect verification is in accordance with the Combined Method. As an illustration may be cited the law of 'acceleration.' Galileo undertook the task of ascertaining the law of the velocity of falling bodies. There occurred to him the hypothesis of acceleration, that is, variation of velocity with the time of the fall. He could not test the hypothesis directly. By mathematical *deduction*, however, he concluded that if a body did fall in the way suggested, then the distance through which it would fall

should be proportiooate to the square of tho time. This consequence could be directly tested by observations.

(*b*) Systematisation of many laws marks the progress of a science and this purpose also is very well served by the Combined Method. The usual way of establishiog such systematisation is by discovering some hypothesis from which certain laws, already obtained by previous inductioos but apparently standing in no relation, can all be derived by deductive reasoning. In this way Newton showed that Kepler's three laws of planetary motion, namely, (1) The planets move in elliptical orbits (2) The velocity is such that an imaginary line joining the planet to the sun sweeps out equal areas in equal intervals of time and (3) the squares of the times of their revolutions round the sun are proportional to the cubes of their mean distances from the sun, could all be *deduced* from the law that bodies tend to move towards each other with a force varying directly as the product of their masses and inversely as the square of the distaoces between them, which is called the Law of Gravitatioo.

(*c*) Sometimes, the Combined Method is employed for mutual support. In the study of highly complex phenomena which are beyond the control of the investigator, such as economic and other social phenomena, it is very unsafe to put faith in the simpler inductive methods because they might be based on a comparatively *few* and *unvaried* instances. It is still more unsafe to trust purely deductive reasoning because there is the risk of overlooking all sorts of modifying or conteracting factors. In such cases, the best that can be done is to employ both procedures (Induction and Deduction) and if they both converge towards the same conclusion, one's confidence in the result is naturally

greater. Purely deductive reasoning, being too abstract, stands in even greater need of inductive confirmation than Inductive reasoning stands in need of deductive confirmation, in the case of complex phenomena. Conclusions drawn only by deduction (the Malthusian Theory, for example,') have often turned out to be mistaken. As an example of securing mutual support may be quoted Spencer's proof for the doctrine that Industrialism promotes free institutions. The first part of his argument is inductive, involving the use of the Methods of Agreement, Difference and the Joint Method, from a survey of conditions in Athens, the Dutch Republic, Norway, United States, Britain, etc. and their industrial regions, in particular. The second part of Spencer's argument is deductive. He shows there that industrial activities are effected by free exchange; such an equal and unforced relation soon becomes predominant and produces social units which have corresponding social arrangements; thus arises a type of society characterised throughout by the same individual freedom which every commercial transaction implies.

QUESTIONS ON CHAPTER VIII

1. Explain the general character of the Indirect Inductive Method (that is, the Method of Hypothesis).
2. How is the Direct Deductive or Physical Method distinguished by Mill from the Inverse Deductive or Historical Method ?
3. What is meant by the Comparative Method ?
4. What are the main uses of the Combined or Deductive-Inductive Method ?

CHAPTER IX

EXPLANATION AND LAWS

(A) Explanation

(I) Meaning of Explanation

The motive underlying the establishment of causal connections between phenomena, which the Direct and Indirect Methods of Induction help us to set up, is the urge for orderliness felt by the human mind in general and by the scientific mind in particular. In the case of physical phenomena, the causal relation constitutes a relation of greater unity and continuity than other uniformities which are not causal. This breaking down of the isolation and setting up connections between things is what is meant by *Explanation*, in science, (the causal relation being only one type of it). *Explanation*, therefore, consists in uniting things and making them appear "simple, orderly and intelligible." " To explain anything," writes Mellone, " is to connect it with what we already know; and this is done by generalising, by bringing the particular or less general under the universal or more general. " In the simplest language, to explain is to make familiar what is unfamiliar. Carveth Read defines it thus, " Scientific Explanation consists in discovering, deducing and assimilating the laws of phenomena. " All xplanation involves generalisation and it has been said

that " All Induction is progressive Explanation. " Similarly Prof. Wolf writes, "To explain anything is to see, or to indicate, its place in some order of things or events, " and " Anything is explained when it is shown in its relation to some other thing or things, so that it does not appear, so to say, to hang in the air, detached and isolated. " The same idea is expressed by Welton and Monahan thus, " Explanation consists in assigning any given fact a place in the system of knowledge by establishing its relations with other facts within the system. " A comprehensive definition of Explanation is given in Latta and Macbeath's " The Elements of Logic " (P. 265) " The purpose of science is to explain and we are said to explain a thing when we show that it is an instance of a law or laws, or an element in a system, the effect of a cause, the means to an end, etc. We cannot explain anything by itself. We have to connect it with other things within a system. "

(2) Types of Explanation

It has been said in the above definition of Explanation that the purpose of science is to explain. But modern scientists are unanimous in maintaining that the purpose of science is not to explain but to *describe* the phenomena of Nature. However, when they say so, they have only one special meaning of Explanation in their minds, namely, Explanation by Purpose or " Teleological Explanation " as it is called in the technical language of Philosophy. We are most familiar with explanations of the conduct of our fellows and that is always explained by reference to purpose. When the scientist rejects explanation he rejects it in this special sense; but in the more general sense he cannot reject explanation; for description is impossible without interpretation, and interpretation is explanation. Even observation, as

previously remarked, cannot easily be kept aloof from interpretation; much less can description. Scientific description, in short, is itself a kind of explanation.

From the above quoted comprehensive definition of Explanation, it is obvious that there are diverse ways and grades of Explanation, ranging from the popular Explanation of " It is always so " (for example, if a lay-man is asked why *water from a fountain* comes off *in spouts*, he will answer, ' It always comes like that ') to the most scientific induction or generalisation (for example, in the above case, a scientist will explain the phenomenon by an ' analysis ' and ' synthesis ' of the laws of motion, of liquids, of pressure, etc.) But generally *three* modes of Explanation are recognised in science, namely, (1) *Analysis* (and, ipso facto, synthesis) (2) *Interpolation* or concatenation and (3) *Subsumption*.

(1) *Analysis* means stating the cause or the combination of causes. As already pointed out, explanation by causal relation is the most satisfactory. By means of *Analysis*, facts may be explained by a causal law or a law explained as a combination of many laws.

Illustrations :— (i) The bent appearance of a stick partly immersed in water may be explained by reference to the law of Refraction. (ii) The successive positions of a planet may be explained by reference to Kepler's Laws. (iii) The equiangularity of a triangle is ' explained ' by its equilateralness. (iv) The motion of a projectile in a parabola may be explained as a result of the first Law of Motion and the Law of Gravitation.

(2) *Interpolation* or Concatenation consists in stating the intermediate steps of causation between two remote events.

Illustrations :– (i) The perception of sound is explained by the mediation of air-waves between the source of the sound and the hearer. (ii) " No cats, no clover. " The absence of clover may be shown to be the remote consequence of the absence of cats. If there are no cats, mice abound ; the mice stop the growth of bees and there being no bees to fertilise clover, there is no clover.

Explanation by interpolatioo is largely resorted to in Economics. The far-reachiog effects of a certain economic change are traced out.

(3) *Subsumption* or " bringing under " consists in showing a law to be a particular case of a wider law.

The best illustration of such an explanation is the explanation of Kepler's three laws of planetary motion as all following from one Law, the Law of Gravitation.

(3) Grades of Explanation

There are as many grades or degrees of explanation as there are of laws, as to explain is to bring under a law.

(B) Laws

Laws may he classified as under :–

(1) Theories

A theory may he distinguisbed from an ordinary law as being more comprehcosive aod speculative than a law and as indicatiog a formulated explaoation rather than an objective uniformity. Thus, laws are *discovered*, but theories are *invented*. The invention of theories marks an important step forward in the history of a science. For theories colligate secondary laws, just as a law colligates or orders facts. A theory is a network of many laws woveo together. Thus we speak of the *theory* of Evolution, involviog the *laws* of ' struggle for existence,' ' natural selection,' etc.

(2) Axioms

Axioms are self-evident Laws; for example, "Things equal to the same thing are equal to one another."

(3) Postulates

Postulates are laws which are assumed to be tru. (that is, not requiring proof) by a particular science; for example, *Law of Uniformity of Nature and the Laws of Thought* are the postulates of Logic.

(4) Primary Laws of Nature

Primary Laws of Nature are Laws which though, capable of proof are of such a fundamental character that other laws are thought to be proved when they are subsumed under these; for examples: the Law of Gravitation in Physics; the Law of Self-preservation in Biology, etc. They are different in the different sciences.

(5) Secondary Laws

Secondary laws are those which *are derivable from* higher laws. Science is chiefly occupied with the discovery of such laws. (A) They can be subdivided into (i) Derivative (ii) Empirical and iii) Semi-derivative.

(i) Derivative Laws are those which are deducible from Primary Laws. They make up the body of *the* exact sciences. Theorems in Geometry (deducible from the nature of Space), the Laws of Planetary motion in Astronomy (deducible *from* the Law of Gravitation), the Laws of Tides in Geography (deducible from the Laws of movement and of liquids), The *Law of Protective Colouring in Biology* (deducible from the law of Natural Selection), are instances of such laws.

(ii) Empirical laws are *thus* defined by *Mill*, "*Scientific* inquirers give the name of empirical laws to uniformities

which observation or experiment has shown to exist, but on which they hesitate to rely in cases varying much from those which have been actually observed, for want of seeing any reason *why* such a law should exist." Mellone defines an empirical law thus, "When a law is ascertained, and we do not know how to connect it with other laws, it is said to be an empirical law." Empirical laws are "laws that have not yet been deduced, and rest upon only actual limited observation or upon some unsatisfactory sort of induction like Simple Enumeration or Agreement." Most of the secondary laws are empirical. They are the "undigested materials of science," and their derivation is the greater part of the explanation of Nature. The formulation of an empirical law forms an early stage in the scientific explanation. The empirical laws cannot be trusted; they have to be changed to suit new circumstances and they hold good only within observed limits, (for example, a law of variation arrived at by the application of the Method of Concomitant Variations). But even empirical laws are better than mere isolated facts. As illustrations of empirical laws may be cited (1) Scarlet flowers are never sweet-scented (2) Horned animals ruminate.

(iii) Semi-derivative laws are those which are partly derived and partly underived. They are common in Meteorology, Geology, etc. For example, the formation of mountain-ranges is partly accounted for but not wholly.

(B) Secondary Laws may also be classified according to their constancy into (i) Invariable and (ii) Approximate. Theorems in Geometry are invariable. The following are examples of approximate laws:—(1) Most arctic animals are white (2) Most cases of plague are fatal. These have greater value if the percentage is stated.

(C) Again, Secondary Laws are of (i) Succession (sequence) or (ii) co-existence.

(i) The succession may be immediate or *remote* or *joint* as in the following three uniformities respectively:– (1) Water extinguishes fire (2) Bad harvests raise the price of bread (3) The night follows the day.

(ii) Laws of co-existence are of several types:–

(1) Those which are general in application and concerned with fundamental properties of bodies; for examples:– " All gravitating bodies are inert " " All monocotyledonous plants are endogenous. "

(2) Those which state a coinherence of a multitude of essential qualities; for examples : " Gold is a metal of high specific gravity, atomic weight 197.2, high melting point, low chemical affinities, etc. " " Lion is a monodelphian mammal, predatory, walking on its toes, etc. "

(3) Those which state a coincidence of non-essential qualities; for examples, " White tom-cats with blue eyes are deaf. " " White spots and patches, in domestic animals, are most frequent on the left side."

(4) Those which state constancy of relative positions; for example, " Three-fourths of the earth is covered with water. "

It is the task of science to reduce the laws of co-existence to the causal relation. It is an extremely difficult task, *particularly* in the case of co-existence of non-essential qualities (the third type). So long as the causal connection is not discovered they remain mere empirical truths

(4) Laws of Nature

The word, ' Law ' has two meanings, one subjective and the other *objective*. *In the subjective meaning*, law

means the *formula* by which facts are summarised, a mental shorthand. Laws, in this sense, may undergo (and actually are undergoing) change. In the objective sense, law means the regularity or uniformity in the character or relation of facts, an orderliness belonging to things as of their own nature and not imposed on them from outside. In this sense, a law is said to be a " Law of Nature. " A law of Nature, therefore, is a statement of the causal or some other *uniform* connection between facts or events in Nature. A Law of Nature, from its very nature, in unchangeable. The usual maxim, " Exception proves the rule, " does not apply to a Law of Nature. The apparent exceptions are generally due to (1) the law not being accurately ascertained, or (2) the circumstances not being correctly observed, or (3) one or more agents in the whole cause being omitted (for example, in determining the laws of Tides, only the Moon's influence is taken into account, the Sun's being neglected) or (4) extraneous agents or circumstances being added. There are thus no real exceptions to the Laws of Nature. If facts do not support them, they must be modified to suit the facts.

(5) Limits of Explanation

If to explain is to connect a fact or event or a law with another or others already known, it is difficult to see why anything should be incapable of explanation. Theoretically, therefore, no limit can be placed on the reach of Explanation (as likewise no limit can be placed on Definition). But from a practical point of view, scientific explanation (and for the matter of that even philosophical explanation) must stop somewhere. So, generally, the following are held to be incapable of explanation :-

(1) Axioms and Postulates

(2) The ultimate cause of the Universe

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(1) Axioms and Postulates
(2) The ultimate cause of the Universe

(3) Fundamental states of consciousness, like colour, heat, smell, pleasure, pain.
(4) An *individual* (because every *individual* has an inexhaustible character).

QUESTIONS ON CHAPTER IX

1. What is meaot by Explanation in science?
2. Mention and illustrate the chief types of Explanation.
3. Enumerate the different varieties of Laws.
4. What is meaot by Laws of Nature?
5. Which facts or Laws are geoerally held to be incapable of explanation? why?

CHAPTER X

ANALOGICAL REASONING

(1) Meaning of Reasoning by Analogy

Though inductive inference consists in starting from particular facts of observation and reaching a, more or less, general conclusion, the type of reasoning, where a particular conclusion *is reached by a comparison of two* particular cases, must be called inductive as it satisfies the essentials in its basis (though not in the conclusion). This type of reasoning is called " Argument from Analogy." The word, " Analogy," has had different meanings. Aristotle meant by *it* ' equality of ratios,' or proportion; for example, the relation between 4 and 8 is analogical to the relation between 2 and 4. Analogy may mean (loosely) any resemblance between two things or events. In this sense, all similes are analogies; for example, " the wind drives the clouds as the shepherd drives the cattle " would be an analogy. In Logic, however, Analogy means " preponderating resemblance between two things such as to warrant us in inferring that the resemblance extends further." For example : *If* A and *B* have *many important* points of

resemblance, and then A is known or discovered to possess an additional quality, to infer that B also probably possesses that quality is to infer by Analogy. The argument from Analogy is different from Simple Enumeration. In Analogy, it is not the *number of instances* but *points of resemblance* between *two* individuals, that are important. Inference by Analogy is reasoning by parity, not parity of reasoning. To illustrate: Earth and Mars are both planets (1) revolving round the sun (2) borrowing their luminousness from the sun (3) rotating (4) having moons and (5) subject to gravitation. Now, the Earth being inhabited, Mars is very probably inhabited also.

(2) Rules for Argument from Analogy

The following rules are to be applied :—

RULE I

Generally, the probability of the conclusion is to be based on the *ratio* of the points of resemblance to the sum of points of difference and unknown points. Supposing A and B resemble in 8 points and differ in 3 points, (2 points remaining unknown) any additional quality discovered in A is likely to be possessed by B with 8 : 5 probability and not 8 : 3.

RULE II

Attention must be paid to the *importance* of the points of resemblance and not to their mere number. Mere assemblage of trifling points of resemblance counts for nothing if the points of difference though fewer are more important. For example, if there are two students, both girls, both beautiful, both studying in the same class, both staying in the Hostels, both unmarried; and one of them is -

known to have passed in the examination, inference that the other must have also passed would not be very sound, as sufficient attention has not been paid to the habits of study, intelligence, heredity etc. which are the more important factors. That is why it is said that "In Analogy, we must *weigh* the points of resemblance, not simply *count* them."

RULE III

Care must be taken that the points of resemblance considered are *independent* ones. If any of them are causally connected, all the causally connected ones really form only one point. For instance, in the illustration above given, "revolving round the sun" and "subject to gravitation" are not really two points but one, the former being the result of the latter.

(3) Weaknesses of Analogical Reasoning

(i) It cannot yield a strict ratio at all, as the unknown points cannot be counted but only rougbly estimated.

(ii) It cannot be applied to cases where the causal connection or disconnection is already ascertained. For example, if it is a known truth that life on earth is due to its hot-and-moist atmosphere and it is ascertained that there is no atmosphere at all on the Moon, and that the atmosphere on Mércury is hot but not moist. and that on Saturn is cold, there is an end of the matter and no room is left for Analogical reasoning. Hence it is said that "in a certain sense the Argument from Analogy is based on our ignorance."

(iii) It is applicable only at an advanced state of knowledge. If the points known are few and the unknown part is estimated to be very large it is unwise to use the argument.

(iv) There is, in addition, a difficulty created by a *Conflict of Analogies.* If a certain individual resembles a second in certain points and a third in some other points, it is difficult to determine which analogy is to be accepted. For example, when *the sponge* was not known to be an animal, and had equal affinities to both vegetable and animal life, it was difficult to say which was the more probable analogy. Similarly, the whale seemed to have some affinities to fish and some to mammals.

(v) It gives only probability and never certainty Certainty requires the strict causal connection; but when that is discovered, the argument ceases to be analogical It is commonly said that "the value of an agrument from Analogy ranges from certainty to zero." So by itsel Analogy establishes nothing, notwithstanding the frequent reference one meets with to what is called "proof by analogy."

(4) Value of Analogical Reasoning

In spite of the above-mentioned weaknesses, *the argument* from Analogy possesses great value in science, (1) In the first place, it *suggests a hypothesis* about the causal connection. (2) Secondly, though not certainty, it provides some sort of probability and "probability is the guide of life." So, the reasoning is much availed of in practical life where the exigencies of life do not admit of an indefinite waiting for certainty. It was analogy that led to the discovery of gold in some Australian hills by means of their resemblance to the gold-possessing hills in California. (3) The argument from analogy attains a very high degree of probability when there is what is called "the Convergence of Analogies." For instance, there is a 'convergence of three analogies in the following set of reasonings :—

Valleys, after glacial action on them, have (1) striated rocks, (2) perched boulders, (3) moraines. A particular valley has all of these; therefore, that valley might have been overrun by glaciers.

(5) Fallacies incident to Analogy

The Analogical reasoning easily lends itself to error. (1) There is either a *False Analogy* altogether or (2) the *force* of the analogy is overstretched, and when overstretched an analogy becomes misleading or (3) the *direction* of the analogy is misunderstood. What is called "damning by faint praise" is an instance of sophisticated analogy. On account of these tendencies to error, analogies are said to be "the stock in trade" of politicians (who carry off by means of rhetorical devices like Analogy); and Heine is reported to have said, "Save us from the Evil One and Analogies." As examples of fallacious analogies may be cited the following:—

(1) "The state is an individual writ large." Both have a period of infancy and youth. Every individual must die; therefore, every state must perish. [The analogy is wrongly extended to death]

(2) The state is like a serpent, going by devious ways. The serpent casts off its slough annually, therefore, Parliament must be changed *annually*. [False Analogy, as there is hardly any important resemblance between the state and the serpent].

(3) A state and a ship are alike. The captain of a ship cannot do his work well if he were to consult his sailors about every the least movement of the ship. So, Carlyle argues, repesentative governments can do no good, in a state.

QUESTIONS ON CHAPTER X

1. Explain the nature of Analogical reasoning.
2. "In Analogy, we must *weigh* the points of resemblance, not simply *count* them" Elucidate.
3. What are the weaknesses and the advantages of the Argument from Analogy?
4. To which errors is Analogy prone?

CHAPTER XI

Fallacies

Fallacies pertaining to Deduction have been stated at the end of Part I. Though it is not possible to separate entirely the form and matter of reasoning, certain errors seem to creep in on account of the deficiency in the matter as certain others on account of that of form. These errors have been already explained in connection with the topics to which they appertain. They may be re-stated in a summary form :—

(1) Fallacies incident to the processes auxiliary to inference.

More prominent among these are (1) *Definition in a circle*, ("the vicious circle"), *cross-division* (which is the result of the employment, at one and the same time, of more principles of division than one.) and *Artificial Classification* (which has hardly any scientific value)

(2) Fallacies incident to the processes preliminary to Induction

Non-observation and *Mal-observation* appertain of

observation. They have been explained and illustrated in the Chapter on Observation and Experiment.

Illegitimate Hypothesis is any hypothesis which is unsound.

(3) Fallacies incident to Induction

1 *Illicit generalisation*, that is to say, generalisation based on insufficient data, like *Imperfect Induction*..

2 *Argument from Authority* (which is deduction and not induction at all.)

(4) Fallacies incident to Inductive Methods

I *Pro causa non causa*, that is, stating as a cause what is not a cause. This has two forms. (1) *Hysteron proteron* (or " putting the cart before the horse " which consists in reversing the order of cause and effect by calling the actual effect as the cause and the actual cause as the effect. For instance, to call yellowness of the skin as the cause of jaundice. (2) *Post hoc ergo propter hoc* (After, therefore; because of).This is the commonest fallacy. A causal sequence is mistaken for a causal one. One recovers from an illness *after* drinking the water of a particular river; if the recovery is attributed (without analysis of the water or diagnosis of the disease) to the water, this fallacy is committed.

II *Mistaking joint effects* for cause and effect is another. People on a particular sea-coast always caught cold on the arrival of a ship The attack of cold was attributed to the arrival of the ship. Afterwards it was discovered that both the cold and a ship's arrival were the effects of a particular type of wind blowing.

III *Neglecting the mutuality* of cause and effect and taking only a one-sided view. For example, to infer that industry increases wealth without noticeing that wealth in turn increasses industry.

(5) Fallacies incident to Analogy

These are mainly three—

(1) *False Analogy* (i e. setting up an analogy in the wrong place. For instance, the analogy between the state and the ship (referred to under Analogical Reasoning)

(2) Overstretching the force of the Analogy; for Instance, the analogy between the state and the individual stretched to their " deaths ".

(3) *Mistaking the direction of the Analogy*: For example, to stress the resemblance inspite of overwhelming differences (which point the other way).

Prof. Mellone summarises the material fallacies under three heads, namely (1) Erroneous observation (2) Erroneous Analogy and (3) Erroneous generalisation. This is an excellent summary.

QUESTIONS ON CHAPTER XI

1. Explain and illustrate the fallacies of non-observation and mal-observation.
2. In how many wrong ways may a causal connection be interpreted ?
3. Mention and *illustrate the fallacies incident to* Analogy.
4. Write notes on (1) Cross-division (2) Artificial classification (4) Illicit Generalisation.